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Agricultural Engineering

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JAMES BASSELMAN, *Editor and Publisher*

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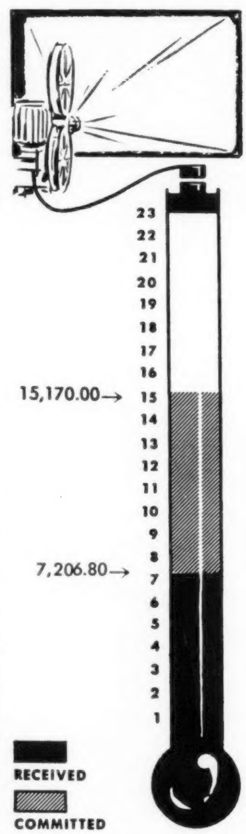
Ford Tractor Companies Expand Scholarships

TWO Ford tractor companies have combined efforts to make available annual scholarships amounting to $2400 for the agricultural engineering department at each of the universities of Georgia and Florida and Auburn University. Four scholarships will be available for each school in the form of $700 each to one senior and one junior and $500 each to an additional senior and junior.

G. H. W. Schmidt, president of the Florida Ford Tractor Co., Jacksonville, Fla., whose company has been granting four scholarships, arranged through the J. W. Schippmann Foundation (known as the J. W. Schippmann Scholarships) to the University of Florida since 1955, recently informed D. T. Kinard, head of agricultural engineering department, that the awards would be increased to $2400. H. T. King, general manager, of the Southeast Ford Tractor Co., Decatur, Ga., reports that his company has established the same scholarship program at Auburn University to be administered by F. A. Kummer, head of the agricultural engineering department. Both companies will share in providing for a corresponding program at the University of Georgia to be administered by R. H. Driftmier, head of the agricultural engineering department.

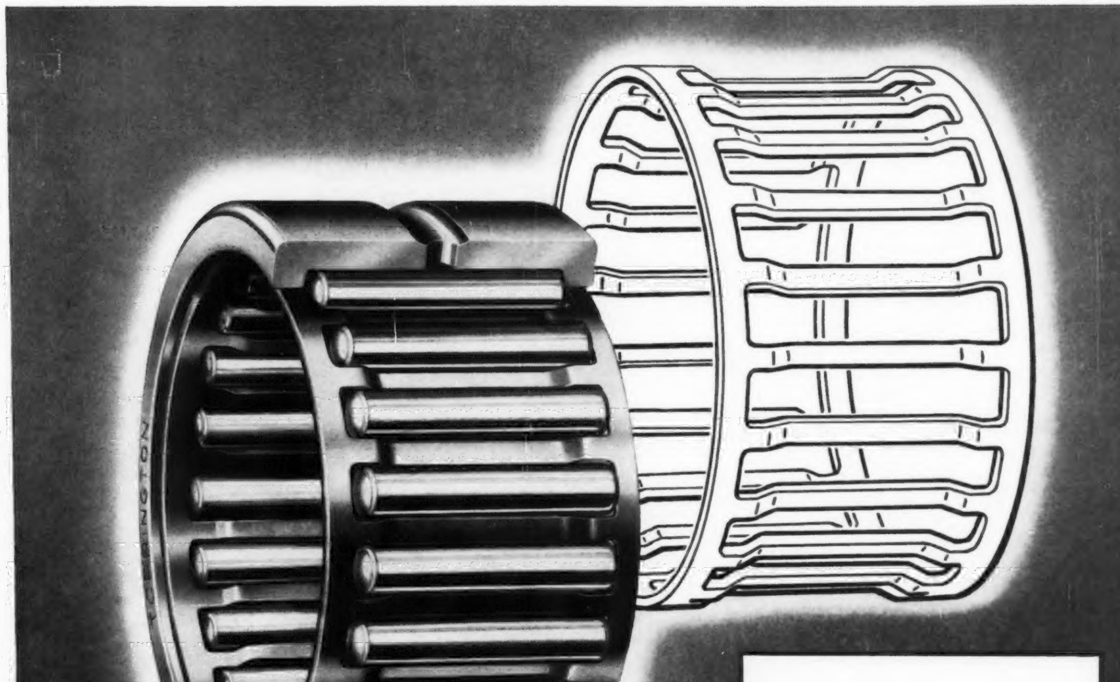
The latter awards will be known as the Alabama and Georgia Ford Tractor Scholarships. In announcing the scholarships the two companies expressed the hope that this evidence of their interest and faith in agricultural engineering would stimulate enrollment and enable worthy students to devote more time to study and development for future engineering service to agriculture.

Motion Picture Report



DURING the month of March cash received for the ASAE Motion Picture Fund amounted to $692.00 bringing the total to $7,206.80. Payment for copies of the film by two universities accounted for most of the cash received. The Ohio Section has now joined the ranks of the paid-up sections, bringing the total to 23, of which 10 have oversubscribed. Although commitments, as depicted on the "Progressometer" and equal to $15,170.00, fall far short of the estimated goal, it should be pointed out that the quota of $7,000.00 assigned to industry has not been included. If it were possible to accept industry's assigned quota as a commitment the established goal would nearly be reached. As yet contributions from industry have not been reported. This is because solicitations from industry were delayed until confirmation of support by ASAE members, themselves, had been established. It was considered best to ask for industry support of an ASAE-sponsored project after it had first received the support of ASAE members. Now that this support has been determined we should soon be able to reduce the uncommitted balance of the goal set for completion of the motion picture project.

Word from the Motion Picture Production Committee indicates that the film will be completed May 1 and that it will be available for a showing during the Annual Meeting.

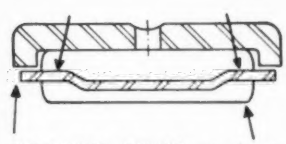


The New *Torrington Heavy Duty Roller Bearing*

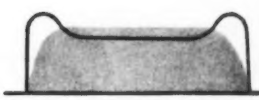
Key to Long Life... Roller Guidance Where It Counts!

This sturdy flange-riding retainer in Torrington Heavy Duty Roller Bearings insures the highest degree of roller guidance where it's most effective... at the roller ends along the pitch circle. You get outstanding service life through minimum internal friction, high roller stability and efficient lubrication.

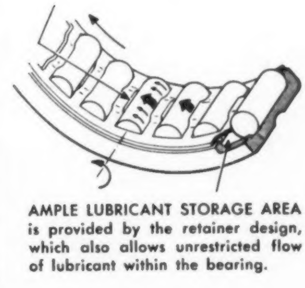
Controlled contour rollers prevent high end-stress concentrations. Careful heat treatment of the channel-shaped outer race insures high shock resistance. The Heavy Duty Roller Bearing has proved successful under unusual conditions of deflection or misalignment. Torrington Heavy Duty Roller Bearings are giving longer life in such difficult applications as two-cycle engines, hydraulic pumps, oil-field equipment, sheaves and transmissions. For design and application assistance on the Heavy Duty Roller Bearing—and every basic type of anti-friction bearing—call your Torrington District Engineer.



END-GUIDED ROLLERS—sturdy retainer guides rollers at ends—at roller pitch circle, reducing stress on retainer, assuring effective guidance and minimum internal friction.



UNIFORM LOADING—Torrington controlled contour rollers eliminate stress concentration at roller ends. End-stress pattern of unrelieved cylindrical rollers is shown in black outline. Area in gray shows uniform loading over entire contact length of Torrington rollers.



AMPLE LUBRICANT STORAGE AREA is provided by the retainer design, which also allows unrestricted flow of lubricant within the bearing.

progress through precision **TORRINGTON BEARINGS**

THE TORRINGTON COMPANY Torrington, Conn. • South Bend 21, Indiana

NEW ONE-OF-A-KIND MICROGRAPH
draws pictures for bearing research

This greatly magnified stylus is drawing a picture of the microscopic imperfections in a bearing raceway . . . measuring each one to within a few millionths of an inch. The picture-on-tape which comes out of this specially modified micrological instrument is an important tool in BCA's research on ball bearing performance.

This is just one of the precision instruments in the Temperature-Humidity-Controlled Instrumentation Room which is the center of BCA research on bearings. The result of this program is revealed in on-the-job performance of BCA bearings. They roll dependably under heavy loads and all kinds of adverse conditions.

New testing facilities at the BCA laboratories also include specially designed equipment, often identical with equipment in customers' plants. Here, BCA bearings are tested to exceed customer specifications *under the exact operating conditions experienced by the customer!*

BCA ball bearings are standard original equipment . . . replacement, too . . . for nearly every kind of industry. For example, automotive, earth moving, agricultural and machine tools. The wide line of ball bearing sizes and types, plus BCA's research and extensive new testing facilities, pays off for bearing users. Consider the performance record of BCA ball bearings the next time you purchase or specify bearings. For more information, or for assistance with bearings problems, contact Bearings Company of America, Division of Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.

BCA

BEARINGS COMPANY OF AMERICA — ball bearings — DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.

Report to Readers . . .

RECOMMENDATIONS FOR DESIGNERS IN THE SELECTION OF FASTENERS

A manufacturer of fasteners recommends that designers of mechanical equipment observe these three steps in specifying fasteners: (a) determine the clamping force required, (b) decide the material and diameter of fastener that will supply the clamping force calculated most economically, and (c) determine the tightening torque that will create the correct clamping force in the assembly. The purpose of the first and second steps is to avoid both the indifferent and the too exact approach to fastener selection. By observing the clamping force required, the designer will stay within the area of the physical requirements needed for the job rather than wander in a maze of chemical specifications of materials. The design approach can best be simplified by staying within the physical requirements. It is best to standardize on one grade of fastener material, rather than use several grades in the same assembly . . . . The correct clamping force having been determined, the designer will then proceed to specify the tightening torque required in an assembly. Unless this last step is adhered to, the holding power specified for a fastener may never be put to work.

YARDSTICK NEEDED FOR TESTING DURABILITY OF FORAGE PELLETS

A young industry agricultural engineer, before an ASAE meeting, stressed the urgent need for wide use of a uniform procedure for testing the durability of forage pellets. He emphasized that the feed industry is experiencing a serious problem of pellet damage in the interval between production and feeding of pellets or wafers. This engineer further stated that, in developing forage-pelleting machinery, the chief concern will need to be to produce pellets sufficiently durable to withstand the rigors of mechanical handling and transportation.

RESEARCHERS PUT FLOORS UNDER SANDY SOILS TO HOLD MOISTURE

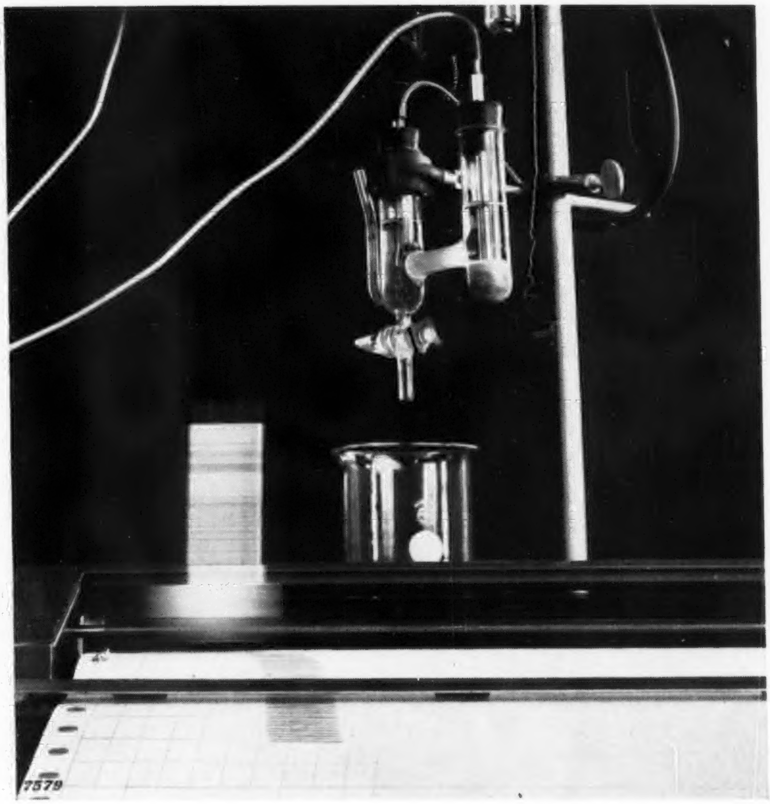
Michigan AES soil scientists and agricultural engineers have undertaken a long-range project to improve the water-holding capacity of sandy soils. Having observed that some of the more productive sandy soils have a natural layer of subsoil containing clay, the researchers conceived the idea of putting down plastic and clay layers in such soils with the idea of forming a moisture barrier, so the soil would hold rain or irrigation water longer . . . . While the agricultural engineers have developed a special tool for putting down a 24-inch wide strip of clay or plastic materials to a depth of 20 to 24 inches, the idea is not considered economically justified at this time. It is estimated that a two-foot-wide strip of plastic placed every other two feet, at a 20 to 24-inch depth, would cost around $200 per acre. However, in light of growing population pressures in so many world areas, such a means of reclaiming potentially productive sandy soils might well become competitive in the future.

BUNKER SILO EQUALS STORAGE EFFICIENCY OF TOWER SILO

A USDA dairy husbandry and agricultural engineering research team, after two years of experiments with storing first-cutting orchard grass in bunker and tower silos, has concluded that the former can be as efficient as the latter. . . . Silage from the same field, with a preservative added, was placed alternately in tower and bunker silos to compare quality and quantity of feed retained and its feeding value. Losses in the bunker silo were kept low by sealing with a plastic cover weighted at the sides and kept covered with 2 to 3 inches of sawdust. The bunker silo was filled quickly and each load was well packed by a tractor driven over it. There was almost no loss from spoilage in any of the methods used, and they were about equal in gaseous loss. All forages were chopped with the harvester set for a $\frac{3}{8}$-inch cut.

(Continued on page 208)

ANALYTIC "BLOODHOUND" SNIFFS OUT SECRETS OF BEARING CORROSION



WE USE THIS HYPERSENSITIVE DEVICE TO TRACK DOWN ENGINE BEARING CORROSION TO ITS SOURCE. This instrument needs only a minute fragment of metal for accurate analysis. Consequently, engine bearing corrosion can be traced from its beginning through complete destruction of the bearing surface. Because test variables are minimized, Federal-Mogul engineers can accurately relate degree of corrosion to specific engine operating conditions. This analytical tool is in continual use in our laboratory, assisting research on many different projects. Prevention of corrosion and development of new bearing alloys are high on the list!

There's much valuable data in our Design Guides on sleeve bearings, thrust washers and bushings; and in our brochure on spacers. For your copies, write Federal-Mogul Division, Federal-Mogul-Bower Bearings, Inc., 11081 Shoemaker, Detroit 13, Michigan.

SUCCESSFUL BEARING PERFORMANCE depends on selecting the proper alloy for the operating conditions to be met. Federal-Mogul engineers have had years of experience with bearings and applications of all kinds . . . and this wealth of knowledge is available to bearings users. This is one reason why F-M sleeve bearings, precision thrust washers, formed bushings, and low-cost spacers are chosen for use in virtually everything from baby buggies to heavy industrial cranes.

FEDERAL Mogul

FEDERAL-MOGUL

sleeve bearings
bushings · spacers
thrust washers

DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.

TREND TO MULTIROW REAR-MOUNTED TRACTOR CULTIVATORS INCREASES As the width of tractor cultivators increases from two- and four-row to six, and now to eight-row, largely in response to farmer demand, the main advantage claimed for the front-mounted type fast loses its significance. Actually rear-mounted cultivators are becoming increasingly popular. In one new six-row model, row spacings may be adjusted from 36 to 40 inches and each gang is provided with a separate gage wheel to control cultivating depth. Parallel-link design gangs mounted on a heavy-duty tool bar keep the pitch of the sweeps the same at all working depths. Side draft on rolling ground is offset by using two rolling guide colters.

TEAR-DROP STYLE PLASTIC SEED PLATES REPLACE METAL PLATES The gradual replacement by farm equipment manufacturers of metal for plastic seed plates in listers and planters is well under way. One company, for example, is making available this season a tear-drop shaped, cell-type plate for planting medium, large and extra large round corn. A new plastic material, known as "delrin", has through extensive testing proven of superior quality for this purpose. Seed plates fabricated of this material have the particular advantage that they will turn smoothly in the hopper, and will not rust. Also, chemicals used in seed treatment will not adhere as readily to the plastic as to the metal plates.

INSIDE-OUT, POLE-FRAME BUILDING DEVELOPED BY RESEARCH TEAM A Minnesota AES engineering-forestry research team has come up with a new, significant concept for a pole-frame farm building. They built the wall of their building by nailing the tongue-and-groove planks to the inside of the poles instead of on the outside. . . . Such construction has certain advantages for machine sheds, cattle loafing sheds, hog farrowing houses and feeding buildings. Less construction time and effort is required since the planks are nailed directly to the upright poles and act as a frame to support the roof. Also, the need for double construction near the ground, when the building is used for livestock, is eliminated. The building has a completely smooth interior which insures better sanitation when it is used for livestock. The researchers consider the building as still in the experimental stage.

NEW ELEVATING PRINCIPLE FOR CHOPPED FORAGES UNDER STUDY Cornell agricultural engineers are investigating a new elevating principle that may well provide the basis for a unit adapted to elevating all types of chopped forages at all angles and at a high elevating efficiency. The basic idea is that of elevating by means of one or two belts running inside a tube. The belts grip the material and carry it upward at high rates of speed, resulting in high capacity and in greater elevating efficiency than a blower . . . . A 32-foot pilot model of this blower has been in use over two years, with various modifications to improve its efficiency. The first unit used a single 15-inch-wide, ruffed-top belt running inside a 10-inch-diameter tube. Equipped with a fingered chain feeder, this unit elevated semicured chopped hay at a 75- to 80-degree angle and at a rate of 10 tons per hour. The unit was driven by a 5-hp electric motor at a belt speed of 1,000 fpm. . . . A second 10-inch belt was added to the unit to run on the upper inside surface of the 10-inch tube, and compression rolls were added under the belts at the tube entrance to facilitate feeding the silage into the tube. These changes resulted in considerably higher capacity for chopped hay. Grass silage was also elevated at a rate of 30 tons per hour, but the power required nearly equalled that for operating a silage blower. Studies of the elevator are being continued to determine the best tube cross section for handling materials with minimum compression, as well as means for reducing friction between belts and tube.

TEAR OUT AND PUNCH AS INDICATED FOR YOUR FILE

SPICER COMPONENTS HELP SOLVE

For over 50 years Spicer clutches and drive train components have been designed into a large variety of agricultural machinery.

Spicer clutches for agricultural equipment include:

Split-Torque Type Clutches which deliver torque flow from one power source to do two *different* jobs. Available in sizes from 8½"-12", with nominal torque capacities ranging from 165 to 390 lbs. ft.

Spring Loaded Type Clutches for smooth steering and/or master clutching on tractors as well as other specialized and conventional equipment. Available in sizes from 6½"-12", with torque capacities tailored to specific requirements.

Constant Pressure Type Clutches — Used with live PTO's on wheeled tractors, heavy-duty crawler tractors and other off-highway applications. Available in sizes from 6½"-17", with nominal torque capacities ranging from 93 to 1420 lbs. ft.

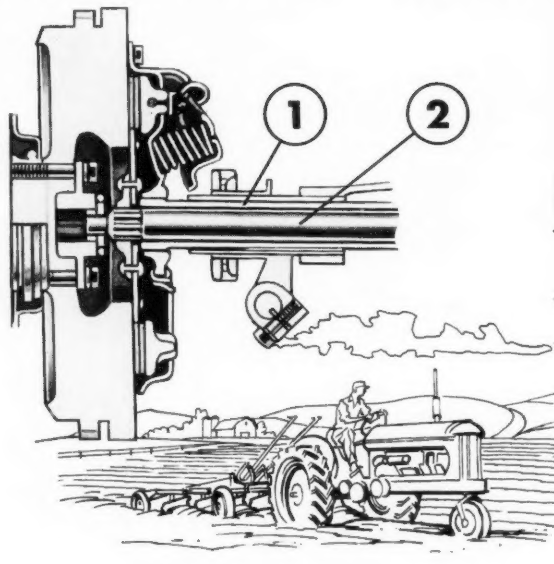
Dual Drive Type Clutches supply selective drive to both tractor and implements with single pedal control. 9"/11" size has a nominal torque capacity of 152-202 lbs. ft. The 10"/12" size has a capacity of 261-306 lbs. ft.

Dana manufactures a wide variety of smaller axles for incorporation into self-propelled agricultural equipment designs where axle carrying capacities from 1000 to 5000 pounds are required. A complete range of gear ratios is available in the popular models.

Since the axle tubes are pressed into the center section, Spicer axles can be adapted to a great many variations in mounting arrangements as well as tread and wheel end design, by changing only the axle shafts and tubes. The center section is not affected. The economic advantages of this flexibility are evident in low piece prices and minimum tooling costs.

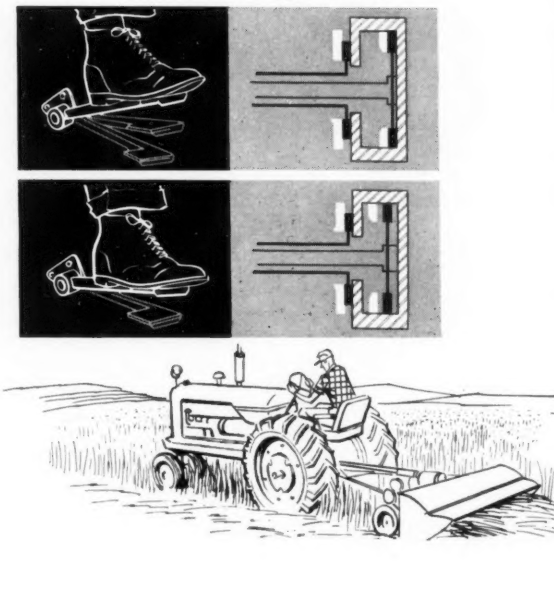
Spicer Telescoping Square Propeller Shafts are available for use with all types of agricultural PTO applications for continuous or intermittent service. No welding or realignment necessary.

Write now for information on the complete line of Spicer clutch and drive train components.

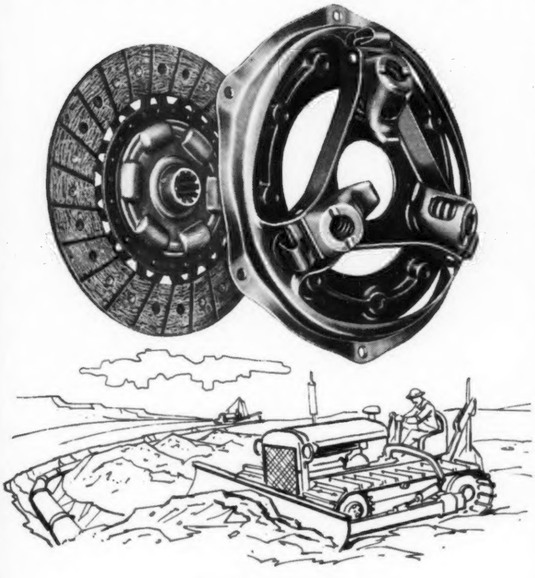


Split-Torque Type Clutches

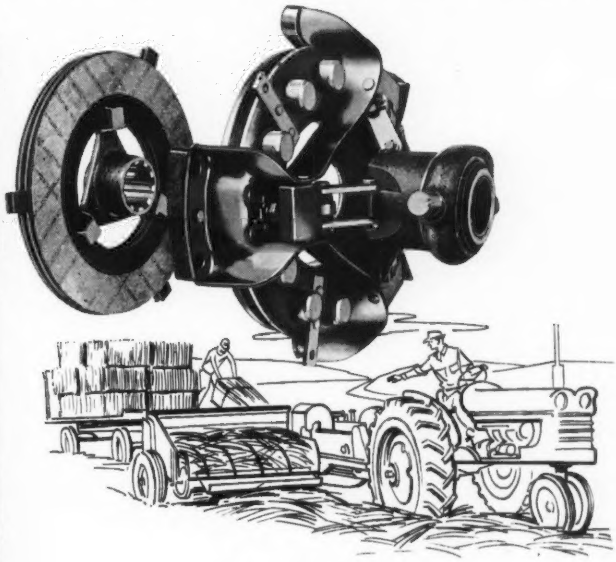
Dual Drive Type Clutches



POWER TRANSMISSION PROBLEMS!



Spring Loaded Type Clutches



Constant Pressure Type Clutches

Spicer Axles

Tree Knocker developed by P. A. Radocy & Sons

Spicer Telescoping Square Propeller Shafts

DANA Spicer

DANA CORPORATION

Toledo 1, Ohio

SERVING TRANSPORTATION AND AGRICULTURE—
Transmissions • Auxiliaries • Universal Joints • Clutches
Propeller Shafts • Power Take-Offs • Torque Converters
Axles • Powr-Lok Differentials • Gear Boxes • Forgings
Stampings • Frames • Railway Drives

Many of these products are manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario

Columbium steel...

solves stamping problems

The cold formed stampings illustrated above are made from Great Lakes' Steel Corporation's GLX-W series of columbium steel. It clearly demonstrates the possibilities that are available to designing engineers. Here can be found high yield strength, with its possible weight reduction, good weldability and satisfactory impact properties. To be able to cold form these parts demonstrates the excellent properties to be had and points to possible production savings.

Molybdenum Corporation, through its own basic research and in close cooperation with various steel companies, has pioneered in the application of columbium to flat-rolled steels. For technical assistance in adapting these steels to your production, consult direct with your steel supplier or address your communication to MCA. No obligation, of course.

MOLYBDENUM

CORPORATION OF AMERICA

2 Gateway Center **Pittsburgh 22, Pa.**

Offices: Pittsburgh, Chicago, Los Angeles, New York, San Francisco
Sales Representatives: Brumley-Donaldson Co., Los Angeles, San Francisco
Subsidiary: Cleveland-Tungsten, Inc., Cleveland
Plants: Washington, Pa., York, Pa.

MCA

STRAIGHT and TRUE

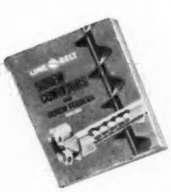
GLEANER-BALDWIN COMBINE, product of Allis Chalmers Mfg. Co., employs Link-Belt screw conveyor throughout for gathering, conveying and elevating the crop.

Exactness of construction is just one of many reasons for designing with LINK-BELT augers

Straight and true! And Link-Belt augers are built to stay that way to assure years of smooth, vibration-free operation. Their strength and straightness result from strict manufacturing controls. Only *selected* steels are used to assure a smooth, accurately rolled product. And specialized forming machinery turns out uniform flighting *consistently*.

Link-Belt augers are available in a full range of diameters, gauges and pitches . . . with helicoid, sectional and many other types of flighting. Link-Belt also has a complete line of troughs, spouts, hangers, drives and other components. For further details, contact your nearest Link-Belt office. Ask for Book 2989.

15,326



LINK-BELT

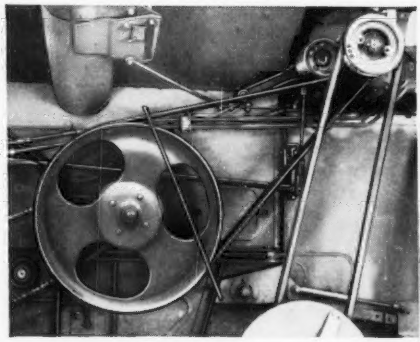
FARM MACHINE AUGERS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Warehouses, District Sales Offices and Stock Carrying Distributors in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

New John Deere 12 Forage Harvester

MANHATTAN *Agricultural Belts*

MEET MODERN EQUIPMENT DESIGN REQUIREMENTS



Close-up of Deere unit shows Condor Flat Whipcord Belt on a separator drive and two Manhattan Agricultural Traction Drive V-Belts transmitting power from engine to wheels through a variable speed sheave.

On job-proven farm equipment like the John Deere 95 Combine pictured above, Manhattan Agricultural Belts assure positive power delivery and long service life where it counts the most—in field operation.

Manhattan belting engineers draw on more than 60 years of rubber technology and experience to produce the most reliable and economical belts available today. The exclusive Extensible-Tip Splice on Condor Whipcord Belts, for example, is a feature found in no other endless farm belt. Other engineered features of strength, flexibility and long service life built into Condor Whipcord Belts and Manhattan Agricultural V-Belts contribute to the success of farm equipment by making power drives as trouble-free as possible.

Let R/M show you why Manhattan Agricultural Belts have won the confidence of leading farm machine manufacturers . . . how they can add "More Use per Dollar" to the equipment you design or produce.

ENGINEERED FOR FARM EQUIPMENT DRIVES

- MANHATTAN AGRICULTURAL V-BELTS
- CONDOR WHIPCORD ENDLESS BELTS
- R/M POLY-V® DRIVES

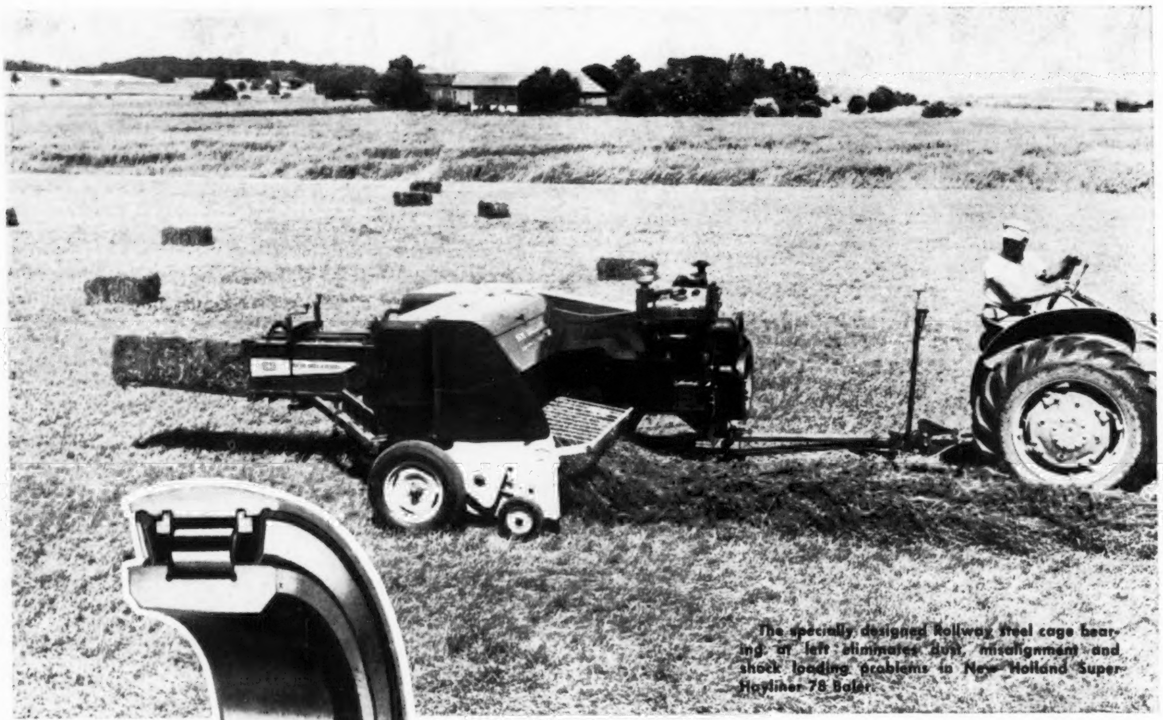
RM1000

RAYBESTOS-MANHATTAN, INC.

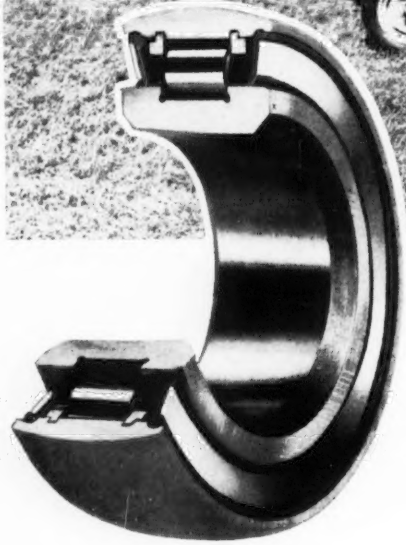
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

RM

ENGINEERED RUBBER PRODUCTS . . . "MORE USE PER DOLLAR"



The specially designed Rollway steel cage bearing at left eliminates dust, misalignment and shock loading problems in New Holland Super-Hayliner 78 Baler.



ROLLWAY

Lifetime-Lubricated

FARM IMPLEMENT BEARING

Extreme stress, misalignment, chaff and dust are some of the job hazards that make a sealed solid cylindrical roller bearing imperative in this New Holland baler. Also, farmers want low-maintenance machines that need a minimum of lubrication. All these requirements were met by Rollway's engineers, who for more than 50 years have been developing the practical out of the possible.

Rollway Bearings are engineered especially for the range, speeds, load shocks and hours-of-continuous-service so important to the farm implement field. Rollway Bearings are superior in metals, fit and finish to most implement specifications.

Whatever your particular requirements might be: either off the shelf, or special designs for special problems—Rollway can supply the right bearing for the right job on tractors and farm implements.

And the price is right!

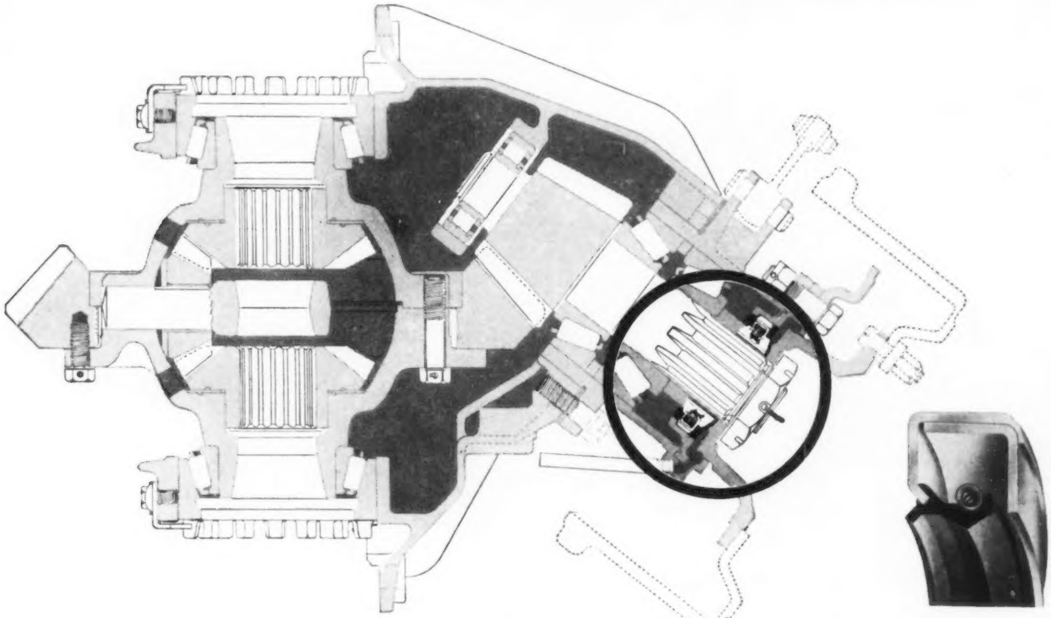
ROLLWAY® BEARINGS

Complete Line of Radial and Thrust Cylindrical Roller Bearings

ENGINEERING OFFICES: Syracuse • Boston • Chicago • Detroit • Toronto • Pittsburgh • Cleveland • Seattle • Houston • Philadelphia • Los Angeles • San Francisco

NATIONAL OIL SEAL LOGBOOK

for the Mack bus



New design seal ends grooving, eliminates costly flange replacement on bus axle carrier

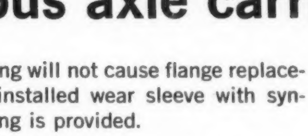
In early designs of the axle carrier assembly for the new Mack bus, a combination of high temperatures, EP oils hardening the sealing lip and a relatively soft sealing surface on the flange caused grooving. It was then necessary to replace the flange, an expensive procedure.

The problem was solved through application of a new National 410,000 series synthetic rubber oil seal. The special compound of the new-design synthetic rubber sealing lip is unaffected by either high temperature or EP lubricants. To positively insure that grooving will not cause flange replacement, an easily installed wear sleeve with synthetic rubber lining is provided.

In buses, trucks, tractors and machinery, as well as throughout American motor car manufacture, National seal engineers work with factory designers to provide better, less costly, more efficient lubricant sealing. This experience is yours at no obligation; simply call the National Seal engineer. Look under Oil Seals, in the Yellow Pages.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio; Redwood City and Downey, California



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Agricultural Engineering

April 1960
Number 4
Volume 41

James Basselman, *Editor*

"ENGINEER" AND EJC

BY now, ASAE, members in the United States should have received Volume 1, Number 1 of "Engineer," the new quarterly tabloid-sized newspaper published by Engineers Joint Council. Distribution, for the present, will be limited to U.S. members of all EJC Member Societies — around 250,000 in number. A slight increase in dues assessed to each EJC Member Society provided the financial support to launch "Engineer," although EJC anticipates that, in the future, some income will be derived from sale of advertising space. ASAE is pleased to join the other EJC Societies in bringing this additional professional service to its membership.

"Engineer" offers much promise as a medium to further the much-discussed cause of "greater engineering unity." It provides an outlet through which information regarding national and international engineering matters, and the work of the various EJC committees may be distributed simultaneously to the members of thirteen leading national engineering societies and eight "Affiliate" societies.* "Engineer" can contribute materially to the engineering profession by reporting on matters which transcend the responsibility and scope of any one society. We look to its further development as a medium for summarizing pertinent professional news for all engineers.

EJC

ASAE members have frequently requested additional information about EJC — its purpose, objectives, activities, membership, and its relationship to ASAE. "Engineer" carried as its first editorial a concise statement of the purpose and objectives of EJC. By way of summary, EJC is a federation of societies dedicated to the betterment of the nation and to the professional, educational, and technical development of the profession and of its individual engineers. It promotes cooperation among the established branches of the engineering profession to advance its constitutional objectives. There is a strong movement toward amalgamation of EJC and ECPD (Engineers Council for Professional Development), the widely recognized accrediting organization, into a single organizational body. EJC does not have individual memberships; rather, its membership is made up of engineering societies, and individual representation is achieved through the existing member societies' organizational machinery.

National engineering societies whose (1) voting membership is confined to individual members and (2) which have as a majority of individual members, engineering graduates of colleges of recognized standing or licensed or registered professional engineers, may apply for Constituent or Associate membership. Constituent societies have more than 5000 voting members, Associate societies have less than 5000. ASAE currently has about 4700 voting members (5500 total membership). Affiliate societies are those which are regional, rather than national in scope, or which are federations of engineering societies, and which otherwise meet the general requirements for membership stated above. A two-thirds vote of the Constituent societies is necessary to elect a society to any category of membership.

The work of EJC can perhaps best be illustrated by brief references to some of its currently active committees. ASAE members serve on a number of these committees, in some instances to present the agricultural engineering viewpoint; in others, to serve as representatives for the entire engineering profession. The ASAE members serving on each committee will be listed in parentheses after the committee designation.

1. *Engineering Manpower Commission* (W. M. Carleton, H. E. Besley) — Objectives are to (a) aid in establishing the importance of engineering to the national economy, (b) aid in maintaining an adequate supply of engineers, and (c) promote the most effective utilization of engineers in support of national health, safety, and interest. Works closely with Scientific Manpower Commission. Reports on manpower matters such as supply, recruiting, and salary trends; military and educational programs. Some examples of the work of this Committee are the publications "Professional Income of Engineers — 1958," "Salaries and Income of Engineering Teachers — 1958," "Trends in Engineering Enrollment — 1957-58-59" (with ASEE), and "Trends in Technical Institute Enrollment." Committee representatives have appeared before the House and Senate Armed Services Committees in the interest of achieving maximum utilization of engineers in civilian or military service.

2. *Committee on International Relations* (E. L. Barger, E. W. Tanquary) — Serves as working body through which EJC functions in international activities. Currently is cooperating in UPADI (Pan American Federation of Engineering Societies), The Pan American Congress on Engineering Education, World Power Conference, International Commission on Large Dams, and a possible Conference of Pacific-Far East Engineering Societies.

3. *National Water Policy Panel* (L. A. Jones, M. L. Nichols) — Works toward adoption of coordinated national policies in the field of water resource development. Conducts surveys and distributes information concerning status of water supply. Keeps in touch with legislative activities on this subject.

4. *Committee on Employment Conditions* (B. T. Virtue, T. W. Edminster) — Collects and prepares for distribution data regarding the economic and social conditions of employment of engineers. Studies such things as mutual responsibilities between employers and employees in maintaining confidentiality of trade secrets, and union activities among engineers. One of the committee's reports, soon to be published, is entitled "Employer Practices and Expectations with Respect to Safeguarding of Proprietary Rights."

5. *Engineering Sciences* — Cooperates in the engineering sciences activities and programs of the National Science Foundation. Helps in initiating and developing basic research and education in engineering sciences and assists in the work of the members representing engineering on the NSF Board.

6. *Labor Legislation Panel* — Reviews the aspects of labor legislation which affect the profession of engineering. Reports to the EJC Board and carries out special assignments in this field as directed by the Board.

Other authorized EJC Committees whose titles indicate the general committee purpose are: *Recognition of Specialties in Engineering* (F. W. Peikert, W. J. Ridout), *Engineers Register Committee* (B. T. Virtue), *Public Relations, National Transportation Policy Panel, Nuclear Congress Committee, Honors for Engineers, Automation, Engineering Information Services, Who's Who in Engineering, Atomic Energy Panel,* and the usual quota of administrative committees.

In summary, EJC with representation from most of the major branches of engineering (with almost one-third of the nation's engineers numbered among the membership of its associated societies; and including engineers in public service work, in private practice, and employed by industry) is rapidly gaining stature as the organization representing the "federation" approach to engineering professional unity. This is the approach through which ASAE and all of its members can be a part of the combined organization of engineers.

**Constituent* — American Society of Civil Engineers (ASCE), American Institute of Mining, Metallurgical and Petroleum Engineers (AIME), American Society of Mechanical Engineers (ASME), American Water Works Association (AWWA), American Institute of Electrical Engineers (AIEE), American Society of Engineering Education (ASEE) American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), American Institute of Chemical Engineers (AIChE), Society of American Military Engineers (SAME), and American Institute of Industrial Engineers (AIIE). *Associate*—American Society of Agricultural Engineers (ASAE), American Institute of Consulting Engineers (AICE), and American Institute of Plant Engineers (AIPE). *Affiliate* — Western Society of Engineers, Louisiana Engineering Society, North Carolina Society of Engineers, Engineering Societies of New England, South Carolina Society of Engineers, Los Angeles Council of Engineering Societies, Kentucky Society of Professional Engineers, and Consulting Engineers Council.

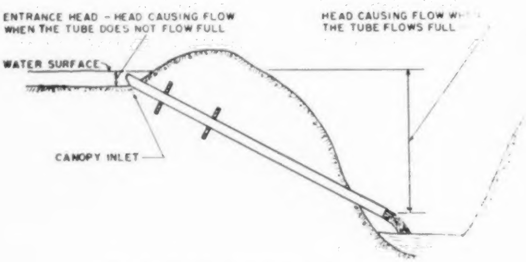

Fig. 1 A tube structure with canopy inlet

Canopy Inlet for Closed Conduits

R. P. Beasley, L. D. Meyer, and E. T. Smerdon
Member ASAE *Member ASAE* *Assoc. Member ASAE*

A design that combines effective performance with simple construction

MANY types of inlets for closed conduits have been used on erosion-control structures, some of which have been relatively complicated to construct or have had poor hydraulic characteristics. The canopy inlet, which combines effective performance with simplicity of construction, is formed by cutting the end of the conduit and attaching an end plate as indicated in Figs. 1 and 2. A discussion of the background information on closed conduit structures is given by Blaisdell and Donnelly(1)*.

Laboratory Studies

Tests were conducted by the authors on models of closed-conduit structures in a small hydraulics laboratory to determine capacities, entrance losses, pipe friction, and other flow characteristics (2).

In a closed-conduit structure, with the conduit slope greater than critical slope, the head causing flow and the resulting flow rate will be greater if the conduit flows full (Fig. 1).

If the end of the conduit is shaped as a canopy inlet (Fig. 2), the flow of water entering the conduit is directed upward. At a relatively low entrance head, this upward component of velocity is great enough to cause the water to impinge on the upper portion of the conduit and thereby cause it to flow full for a short section near the inlet. In the short section of the conduit which is flowing full, the streamlines and thus inertial forces are parallel to the longitudinal axis of the conduit. This results in the conduit flowing full for its entire length.

If the end of the conduit is not modified, that is, if it is perpendicular to the longitudinal axis of the conduit, the flow of water entering the conduit is not directed upward and a much larger entrance head is required to cause the conduit to flow full.

Tests were conducted on models of inlets to determine the most desirable shape of the inlet. Lucite plastic tubes and copper tubes were used in the tests. The copper tubes were scale models of 1-ft, 2-ft, and 3-ft diameter corrugated metal pipe. The inside diameter of all tubes was approximately 2 in. The tube lengths varied from 2.5 to 11.6 ft.

Preliminary tests were conducted to determine the effect of inlet angle, canopy length, end plate, tube slope, tube length, and roughness of the tube on the flow characteristics (3).

Inlet angles varying from 30 to 160 deg were tested (Fig. 3). With inlet angles less than 70 deg, there was no measurable difference in the entrance head required to cause the tube to flow full. The smaller inlet angles resulted in a slight reduction in capacity and a reduction in vortex action. With inlet angles greater than 70 deg, there was an increase in the entrance head required for full flow and an increase in vortex action.

The length of the canopy with a 40-deg inlet angle was varied by cutting the tube perpendicular to its longitudinal axis (Fig. 3). As the canopy length was shortened, vortex action increased. There was no measurable difference in the entrance head required for full flow or in the capacity for canopy lengths greater than 1.2 times the tube diameter. However, a greater entrance head was required for shorter lengths.

An end plate was attached to the inlet as indicated in Fig. 2. The tube flowed full at a lower entrance head than

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Acknowledgment: The authors express their appreciation for the interest and cooperation of Armco Drainage and Metal Products, Inc., and for the materials they contributed for use in the study reported in this paper.

*Numbers in parentheses refer to the appended references.

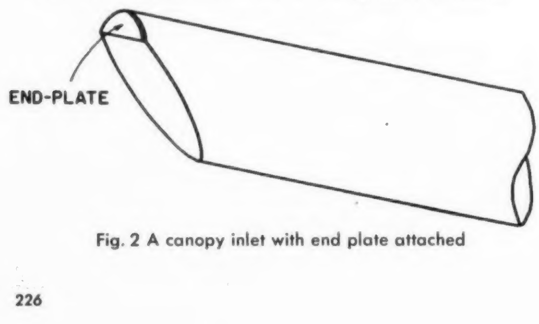

Fig. 2 A canopy inlet with end plate attached

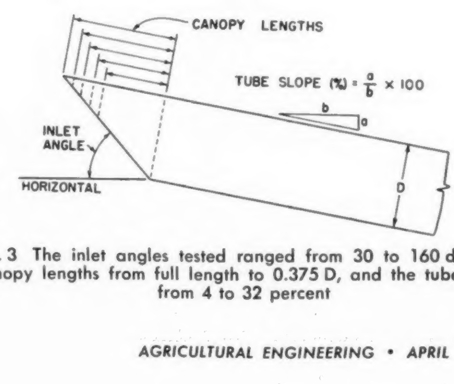

Fig. 3 The inlet angles tested ranged from 30 to 160 deg, the canopy lengths from full length to 0.375 D, and the tube slopes from 4 to 32 percent

Fig. 4 *(Left)* The canopy inlet with a flat-approach channel • Fig. 5 *(Right)* The canopy inlet with the shape of the approach section modified to lower the inlet below the level of the approach channel

with either of the other type inlets. There was also a significant reduction in the vortex action.

The roughness and the length of the tubes tested had no measurable effect on the entrance head at which the tubes would flow full. Tube slopes of 4, 8, 16, 27 and 32 percent were tested. It was apparent that for maximum performance the design of the inlet should be different for different tube slopes.

Preliminary tests indicated that the canopy inlet with the end plate was superior to the others tested. An additional series of tests was conducted to determine the most desirable inlet angle and canopy length for different tube slopes (4). Most of these tests were made using a scale model of a 2-ft diameter corrugated metal tube. The nominal diameter of this model was 1.866 in. and the length was 74 in.

Inlet angles of 30, 45 and 60 deg were tested. For each tube slope and inlet angle, the first test was made with a full-length canopy. The canopy was then shortened by small increments, an end plate attached, and the test repeated. The canopy length was decreased until the capacity of the structure was significantly reduced.

The approach channels tested were similar to those that would be expected in field installations. Two such installations are shown in Figs. 4 and 5. The effect of the direction of flow in the approach channel on the performance of the structure was tested. Most of the tests were run with no obstructions in the approach channel so the water could approach the inlet from any direction. In other tests, deflectors were used to direct the flow in the approach channel. Many different arrangements which directed the flow in different directions were tested.

Results

For each canopy-inlet design tested, the entrance head was plotted versus discharge and the entrance loss coefficient *Ke* was computed. A typical set of rating curves is shown in Fig. 6. In order to compare the capacity of the canopy-inlet structure with a similar structure with an unmodified inlet, the rating curve for the latter structure was also plotted. Observations were made of vortex action, including intensity and whether continuous with time.

The canopy inlets with the end plate attached significantly reduced the tendency for vortices to form. However, when the tube slope was steep, generally in excess of 16 percent and the inlet angle greater than 45 deg, there was a tendency for some vortex action to develop. This action increased as the tube slope and the inlet angle increased. The maximum vortex formed under these conditions reduced the tube capacity less than 2 percent. However, the vortex action may result in some additional scour at the entrance, so it was deemed advisable to design an inlet so there would be no significant vortex action.

During the tests it was observed that vortex action was reduced by shortening the canopy length. However, as the canopy length was shortened, the size of the end plate was increased and the area of the inlet opening was reduced. There was a point at which further shortening rapidly reduced the capacity of the tube. A significant reduction in capacity began to occur when the entrance loss coefficient was more than ten percent greater than the coefficient for a full-length canopy. The canopy lengths which resulted in an increase of ten percent in the entrance loss coefficient were

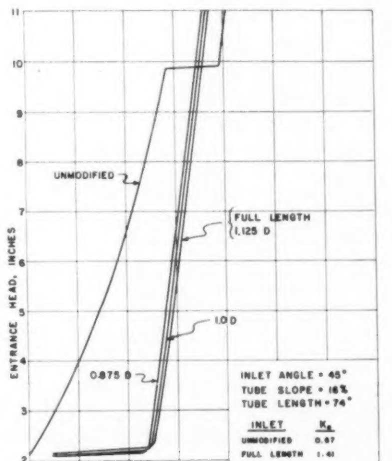

Fig. 6 Rating curves and entrance-loss coefficients for a 1,866-in. diameter model of a 2-ft diameter corrugated-metal, canopy-inlet tube structure and for a similar structure with an unmodified inlet

. . . Canopy Inlet

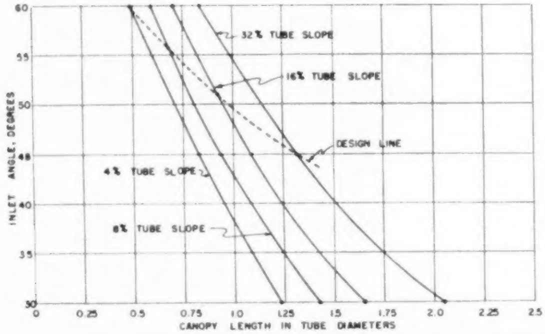

Fig. 7 The solid lines show the minimum practical canopy length for each inlet angle. Shorter canopy lengths will significantly reduce the capacity of the structure. With canopy lengths and inlet angles above the design line, there will be a tendency for vortices to form

plotted versus inlet angle for each tube slope tested. These curves are shown in Fig. 7.

The entrance-loss coefficients increased as the inlet angle decreased from 60 to 30 deg. Therefore, to utilize the lower entrance loss coefficients, an inlet angle near 60 deg would appear desirable. However, the tests showed that steeper tube slopes with an inlet angle of 60 deg resulted in a tendency for vortices to form even after the canopy length had been shortened. This vortex action was reduced by reducing the inlet angle. Therefore, the inlet angle for steep tube slopes must be reduced to less than 60 deg to obtain effective vortex control.

For each tube slope tested, the inlet angle above which vortex action was significant was determined. These inlet angles were indicated on the tube slope curves of Fig. 7. A line connecting these points gives the ideal inlet angle and canopy length for each tube slope. This line is the design line. For near maximum performance and for effective reduction of the vortex action, the recommended values of inlet angle and canopy length should fall on or just below the design line.

The entrance loss coefficient of the canopy inlet varies with the length of the canopy and the inlet angle. If the inlet is designed according to the design line of Fig. 7, the entrance loss coefficient will be approximately 1.5.

The variations in the shape of the approach channel or the direction of flow in the approach channel had no measurable effect on the entrance head at which the tube flowed full or on the capacity of the structure.

Field Tests

A one-foot diameter corrugated metal tube 105 ft long with the outlet 14.5 ft lower than the inlet was installed in the spillway of a lake. Flow from the lake to the structure was controlled by sliding headgates on two 24-in. corrugated metal pipes. Piezometers were installed at 20-ft intervals along the tube to determine when the tube was flowing full. Flow from the structure was measured by a Cipolletti weir.

In order to determine the effect of the direction of the approaching flow, deflectors were used to direct the flow to the structure from any desired direction. Efforts were made to direct the current in such manner as to accentuate the formation of vortices. These approach-channel variations gave no measurable difference in the performance or capacity of the structure. There was no evidence of serious scour in the approach channel. No significant differences between the results predicted from the model tests and results obtained by the field tests were found.

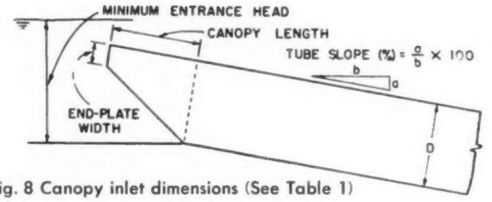

Fig. 8 Canopy inlet dimensions (See Table 1)

Field Installations

The dimensions for construction of canopy inlets and the minimum entrance head necessary for the tube to flow full are given in Table 1 and Fig. 8. When it is desirable to reduce the depth of water impounded, the inlet may be lowered below the level of the approach channel or permanent pool level by forming an approach section as shown in Fig. 5.

TABLE I. DIMENSIONS OF THE CANOPY INLET

Tube slope, percent	End-plate width	Canopy length	Minimum entrance head
0-5	0.19D*	0.54D*	1.4D*
6-15	0.20D	0.8 D	1.5D
16-25	0.27D	1.1 D	1.6D
26-32	0.35D	1.3 D	1.7D

*Diameter of tube.

Summary

A closed-conduit spillway with a canopy inlet is a simple structure which is relatively inexpensive and easy to install. A series of laboratory tests were made on scale models of the structure to determine its hydraulic characteristics and the design dimensions of the inlet. The performance and capacity of the structure as predicted from the laboratory tests were verified by field tests on a full-scale structure.

The tube flowed full with a depth of water at the inlet ranging from 1.4 times the tube diameter for a tube slope of 4 percent to 1.7 times the tube diameter for a tube slope of 32 percent. Vortices had no measurable effect on the performance or capacity of the structure. Variations in the shape of the approach channel or the direction of flow in the approach channel had no measurable effect on the performance or capacity of the structure. The roughness and length of the tube had no measurable effect on the entrance head at which the tube flowed full. The entrance loss coefficient for the canopy inlet is approximately 1.5. The dimensions for construction of canopy inlet structures are given.

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The Nebraska Tractor Tests

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Member ASAE *Assoc. Member ASAE*

Their relation to the new SAE-ASAE Agricultural Tractor Test Code procedure

THE excellent cooperation and mutual confidence that has developed between the engineers of the tractor industry and the University of Nebraska is one of the outstanding features of the Nebraska Tractor Tests. This fine working relationship for nearly four decades has developed from a sound division of responsibilities, consistent policies, uniform test conditions, and continuity in the procedures used for recording and reporting performance data. This paper is intended to review briefly the history of tractor testing and to discuss the Nebraska Tractor Tests in relation to the new Agricultural Tractor Test Code (1)*.

The first tractor and engine competitions were held in Winnipeg, Canada, in 1908(2). Subsequently similar events spread to other places in Canada and the United States which varied in policies, test procedures, test equipment, and the operation and adjustment of the tractors. The test results varied widely. Fortunately, the test results for all national and regional competitions were turned over to the sponsor, the National Implement and Vehicle Association, and to the respective manufacturers for their confidential use. The Association discontinued sponsorship of all such national and regional competitions at the end of 1919 (3).

The next important development in tractor testing also occurred in 1919 when two different groups with widely differing responsibilities voted in favor of the "official" testing of tractors. The first group, the Nebraska State Legislature, on March 13, 1919, recorded an almost unanimous vote for the Nebraska Tractor Law (4). The second group, the tractor and thresher division of the National Implement and Vehicle Association voted unanimously, on April 11, 1919, to request the U. S. Department of Agriculture to conduct tests of tractors to determine both belt and drawbar horsepower and furnish a certificate of results (5). The request presented to the USDA was denied because members of the Agricultural Committee of the Congress were of the opinion that such work should not be done by the Department of Agriculture (6). Starting in 1920, the University of Nebraska put in operation the first and only "official" public tractor test station in the United States. The tests were placed under the direction of a board of three engineers.

Valuable administrative experience was gained from the early national and regional tractor competitions by two members of the first Nebraska Board of Tractor Test Engineers, L. W. Chase and O. W. Sjogren. Other members of the Board were E. E. Brackett and J. W. Haney. C. K. Shedd was the first engineer-in-charge of tests.

During the early years it may have seemed that the intent of the Nebraska tests was to expose design weaknesses in the various tractor models. While many weaknesses were exposed, the principal aim always has been to show potential buyers the highest practical levels of performance under maximum power conditions and the inherent performance characteristics of the tractor under part-load operating conditions.

Policies and Procedures

The policies and procedures followed in the Nebraska tractor tests take into account the interests of both the buyers and the manufacturers. Both groups are interested in having the tests stimulate the improvement of tractors from the standpoint of fuel economy and inherent performance characteristics. Therefore, if a tractor model is not being sold on a temporary permit it is permissible for the manufacturer to withdraw the tractor from test, if it fails to perform as expected, and retest it later after improvements have been made. In addition, the manufacturer has the responsibility of selecting a stock tractor which will give the best performance expected or claimed for the particular model it represents. This tractor is generally prepared for test at the factory so that only minor adjustments are required after it reaches the test station. The manufacturer's representative makes the decisions where choices are permissible or where company policy is concerned. This procedure, though necessarily somewhat flexible, places full responsibility for the selection and adjustment of the tractor on the manufacturer and his representative. This is a sound method of getting the correct mechanical adjustments so that the effect of new developments are reflected by the performance indices. This practice recognizes the fact that performance indices do change even though the basic concept of the tractor remains relatively fixed.

The buyer expects the Board of Tractor Test Engineers to carefully consider his interests when a tractor is being equipped for testing. He is basically interested in comparing the performance indices of two or more tractors equipped with the common power-consuming accessories offered for sale by the manufacturers. These accessories include such items as hydraulic control systems, mufflers, generators, added ballast, etc.

The buyer also wants the instructions in the operator's manual to be followed closely, and he expects a final inspection of key parts of the tractor to discern irregularities in specifications or manufacturing methods. He also wants the advertising literature to be searched for excessive or misleading claims. The comparison between claims and test data is made by the Nebraska State Railway Commission, the delegated administrative authority.

A few examples of excessive claims for power and drawbar pull found in advertising literature recently include *(a)*

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Three of the authors — L. W. Hurlbut, G. W. Steinbruegge, and J. J. Sulek — are members of the Nebraska Board of Tractor Test Engineers. L. F. Larsen — is engineer-in-charge of tractor tests. The authors helped write the new test code.

*Numbers in parentheses refer to the appended references.

the use of the horsepower corrected to standard conditions for a bare engine instead of the mechanical power-outlet horsepower of the tractor equipped with the common engine accessories, *(b)* a "theoretical maximum drawbar pull" based on the peak torque at "peak" engine horsepower and locked traction members, and *(c)* the use of horsepower corrected to standard conditions of a bare engine to represent the power of a tractor equipped only with a drawbar. Reference is often made to "other kinds" of power such as earning power, work power, and pull power. It is difficult to understand why company executives condone the printing of misleading claims for the consideration of their potential customers, since such advertising tarnishes the reputation of the manufacturer. In spite of this fact, the use of excessive claims for power or drawbar pull appears to be increasing. If the claims for power and drawbar pull cannot be demonstrated at the Nebraska testing laboratory, then they must be cleared from the literature before the Nebraska State Railway Commission will issue a permit to sell. Widespread use and compliance with the SAE-ASAE Agricultural Tractor Test Code would eliminate the excessive claims now found in some advertising literature.

The need for changes in both the Nebraska test procedure and the previous SAE-ASAE test code appeared with the trend toward the use of various devices for causing travel speeds to vary inversely with changes in drawbar pull. This trend prompted Steinbruegge and Larsen (7) to analyze various methods for making drawbar tests of both constant and variable-speed tractors and they concluded that drawbar pull should be used (instead of power) as the controlled variable for showing the pull-speed characteristics of a tractor. They recommended that the varying-power characteristics be determined in runs wherein the pull used is a fixed percentage of the pull at maximum uncorrected drawbar horsepower. This procedure is now a part of the new SAE-ASAE Agricultural Tractor Test Code and it provides the important element of continuity with past drawbar tests. The test conditions and test procedures outlined in the new test code are applicable to all types of tractors and the performance indices recorded show differences due to combustion variants, governor control, transmission variants, different traction equipment, and power-consuming accessories.

The new test code acknowledges the fact that the number of different performance indices in an official test report should be kept to a near minimum because both the buyer and the manufacturer are more interested in making general comparisons between two or more complete tractors than making a design analysis of the component parts. Test performance is only one of several factors to be considered when selecting a tractor.

Tractor testing, like any other activity based on competition and performance indices, must have one or more referees, a standard procedure, some ground rules, and the necessary facilities. The referees are the Nebraska board of engineers and the engineer-in-charge of testing. The set of standard procedures and the general specifications for test facilities are outlined in the new SAE-ASAE Agricultural Tractor Test Code.

Certain interpretations of the standard procedures, the formulation of ground rules, the reviewing of data and written material in the test reports, and preparation of the recommendations sent to the Nebraska State Railway Commission are a few of the responsibilities of the Board of Test Engineers. The interpretations within the standard procedures may include such items as *(a)* the use of nonagricultural tires on a tractor requiring tires of special size and ply, *(b)* the quantity of ballast and the kind of attachments that can be added to increase the weight of either wheel-type or track-type tractors, *(c)* deciding that a given stock tractor does or does not represent models in a series which has separate designators to indicate variations in wheel arrangement, accessories, etc., *(d)* establishing the temperature range desirable for power-outlet tests, *(e)* the use of either hydraulic or cable remote controls where a choice is possible, *(f)* the appropriate pump size for remote hydraulic controls, and *(g)* appropriate drawbar attachments and drawbar height adjustment. The test board reaches a decision regarding permissible attachments and accessories after discussing each situation with the manufacturers representative, studying the company literature, talking with retailers of competitive tractors, and referring to any other sources of information such as the ASAE standards for remote hydraulic control (8). However, this standard is limited in its usefulness because it does not clearly indicate either the rate of oil flow or the power requirement. In the case of hitches, the current practice for setting the drawbar height varies considerably from the approved ASAE standard specifications (9, 10). The ASAE standards concerned with hitches should be reviewed carefully in light of the influence of high hitches on tractor performance. It seems logical that the approved standard specifications and the testing practices should be brought into full agreement in due time.

The New Test Procedure

Modification of the Nebraska test procedure in accordance with the SAE-ASAE Agricultural Tractor Test Code involved the addition of four runs (Table 1), and the discontinuation of four runs. A maximum-power and fuel-consumption run at standard power take-off speed was added to cover those cases where one engine speed is specified for maximum power and another engine speed is specified for the standard power take-off shaft speed. Two drawbar runs were added to show the varying drawbar power, speed, and related fuel-consumption characteristics. One of these runs is made at maximum available power; the other at 50 percent of the drawbar pull at maximum power. The third drawbar run was added in 1958 to show the relationship between increasing drawbar pull and travel speed. Three mechanical-power outlet runs were discontinued (the 100 percent maximum run for carbureted engines, the rated load run, and the torque run) in order to make the procedure uniform for all types of engines and minimize the duplication of data. One drawbar run, with the smallest pneumatic tires recommended, was discontinued.

The basic factors involved in planning a drawbar test procedure suitable for modern tractors equipped with either a gear or a variable-speed transmission are drawbar pull, travel speed and the resultant drawbar horsepower. Up until 1959, horsepower was the only base for the runs in all tractor test procedures. Horsepower was a practical base because of the relatively constant pull-speed relationships exhibited by gear-type tractors when tested at a specified engine speed. However, the recent use of governor control and hydro-

TABLE 1. THE SIX TYPES OF RUNS MADE IN THE NEBRASKA TRACTOR TEST PROCEDURE
(N.B.: The procedure in this table conforms to the SAE-ASAE Agricultural Tractor Test Code.)

	Year started
Mechanical Power Outlet Performance*	
Maximum Power and Fuel Consumption†	
Specified engine speed — 2 hours (Former Test C)	1920
Standard power take-off speed — 1 hour	1959
Varying Power and Fuel Consumption — 2 hours‖	1920
85 percent of dynamometer torque at maximum power; minimum dynamometer torque; one-half the 85 percent torque; maximum power; one-fourth and three-fourths of the 85 percent torque (Former Test E)	
Drawbar Performance	
Maximum Power with Ballast‡ (Former Test G)	1920
Varying Drawbar Power and Fuel Consumption with Ballast‖	
Maximum available power§ — 10 or 2 hours	1959
75 percent of pull at maximum power (formerly 75 to 81 percent) — 10 or 2 hours (Former Test H)	1920
50 percent of pull at maximum power — 2 hours	1959
Varying Drawbar Pull and Travel Speed with Ballast	1958
Maximum Power without Ballast** (Former Test J)	1941

*It was permissible to make carburetor settings for each power outlet and drawbar run during the period 1920-27. Data for a 100 percent maximum power carburetor setting was reported from 1935 through 1958.

†The fuel settings established by the manufacturer remain unchanged throughout the remainder of the test. The "operating setting" has been used since Test No. 148, 1928.

‡The drawbar runs for maximum power are limited to 12 travel speeds selected by the manufacturer. Appropriate runs are made both with and without the torque multiplier in operation.

§The pull is adjusted so that the specified engine speed is maintained throughout the straight sections of the test course.

**All liquid and added cast-iron ballast is removed.

‖The governor has controlled the engine speed since the beginning of the 1958 test season. The manufacturer's representative chooses the 10-hr run which represents the continuous drawbar horsepower capabilities of the tractor.

kinetic drives permits the speed to vary over a wide range. In this case, a fixed percentage of the horsepower imposes conditions approaching or exceeding the limits of their practical operating range. To prevent this disparity with gear-type tractors, the manufacturers of tractors with hydrokinetic drives were granted permission, up until 1959, to restrict the drawbar runs by using only the pull at maximum drawbar horsepower. Subsequently the analysis of alternate drawbar-test procedures by Steinbruegge and Larsen showed that a fixed percentage of the drawbar pull at maximum power was the proper basis for showing the varying-power characteristics of both the fixed and varying-speed tractors. Their data also showed the desirability of varying the drawbar pull over a fairly wide range. Therefore, two new drawbar runs, based on drawbar pull, were added to show the varying drawbar-power and fuel-consumption characteristics of a tractor. One run shows the maximum available power obtained by loading the tractor so that the specified engine speed is maintained on the straight, 500-ft sections of the test course. The other new run is made at 50 percent of the pull at maximum power.

The runs at 75 and 50 percent of the drawbar pull at maximum power require the manufacturer's representative to select either the gear (in a fixed-ratio transmission) or the point of maximum power for one "speed range" which the manufacturer recommends for field work. For a tractor equipped with a hydrokinetic transmission, the point of maximum power and the corresponding drawbar pull commonly appears on a rather flat section of the horsepower curve. It is expected that the maximum horsepower selected will come within the travel-speed range that is suitable for field operations. The upper limit of this range is about five miles per hour.

The practice of correcting tractor horsepower to standard conditions has been discontinued. Therefore, in order to minimize variations in temperature and barometric pressure, it is current practice to run the mechanical power-outlet tests with the temperature near 75 F and the barometric pressure near its average level. This practice necessitates some loss of time when the barometric pressure is low and some night-time testing when the daytime temperatures go above 75 F.

New Test Facilities

The drawbar test facilities were expanded in 1956 to include a concrete test course for tractors equipped with pneumatic tires and an enlargement of the earthen course for tractors equipped with metal traction devices. The shift from the carefully watered and well-packed silty-clay loam test course to the concrete test course (with belted finish) caused no significant change in the performance data for tractors equipped with pneumatic tires. It did reduce the variability in the test course and the interruptions caused by precipitation. Detailed care in watering, packing, and blading the surface of the earthen course is continued for the maximum drawbar power and pull runs for tractors equipped with metal traction members. The earthen test course seldom limits the maximum capabilities of the tractor.

Summary

The ultimate purpose of tractor testing is to develop criteria useful in appraising the performance of two or more tractor models. Therefore, the test procedure must be both orderly and consistent if reliable performance indices are to be recorded for comparing tractors of the past, present and future. Performance indices for several tractors are required if a relative appraisal of a particular tractor is made.

The new ASAE Agricultural Tractor Test Code has been planned to show the inherent performance characteristics of a tractor functioning as a complete unit. It is applicable to all type of tractors and the recorded performance indices do show differences due to combustion variants, governor control, transmission variants, differences in traction equipment, and power consumed by accessories. The new test code represents a joint accomplishment of the Society of Automotive Engineers and the American Society of Agricultural Engineers that is helpful to and much appreciated by the Nebraska Board of Tractor Test Engineers.

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8 Application of hydraulic remote control to farm tractors and trailing-type farm implements, *Agricultural Engineers Yearbook*, p. 51, 1959.

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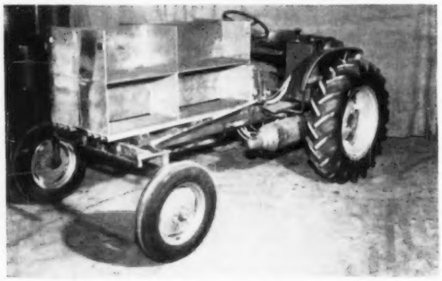
An Electric-Powered TRACTOR

Harry K. Ihrig

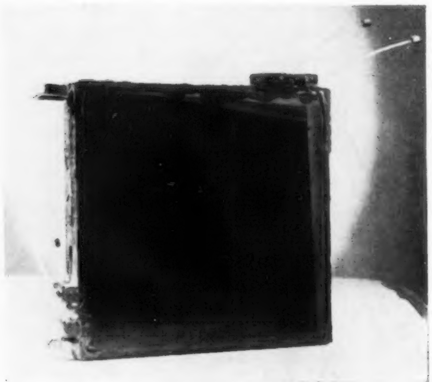
Experimental tractor powered by electric current generated in fuel cells

Regular A-C, D-12, Chassis

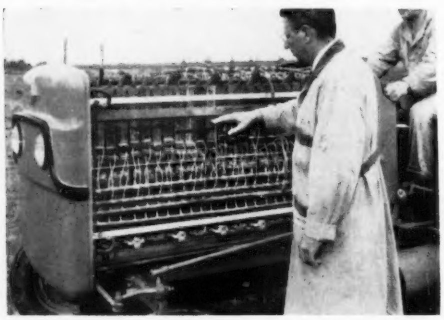
Aluminum Shelves in Engine Compartment



Fuel Cell Unit Containing Nine Cells



112 Units or 1008 Cells for Each Tractor



Figs. 1-4 *(above)* show construction sequence

ALL power plants used in tractors, until now, have been heat engines. In all heat engines the efficiencies are limited. The Carnot principle states that the only energy available in a heat engine is derived from the difference in the initial temperature and the exhaust temperature. This is commonly written $(T_1-T_2)/T_1$. Because of this principle, the best diesel engine is less than 40 percent efficient.

Unless materials are developed that allow heat engines to be operated at much higher temperatures than they are being operated now, there is little chance of bettering their efficiencies by any appreciable amount.

A power plant that operated at ambient temperatures and hence not be a heat engine, and not be subject to the Carnot principle, would have the possibility of achieving much higher efficiencies than that of the diesel. Such a power plant is an electric motor operated by current generated in fuel cells. In these cells, a fuel gas and an oxidant are fed separately into a cell at two electrodes. They react in an electrolyte with the aid of a catalyst. Little or no heat is formed. The free energy of the chemical reaction in the cell is converted into direct current which is used to drive a motor.

The principle of the fuel cell has been known for over a hundred years. Many articles have been published about it. Manion (1)*, Austin (2), and Rosenberg (3) have described its history and given extensive bibliographies. Some of the first fuel cells built in the Allis-Chalmers research laboratories used hydrogen as a fuel and oxygen as the oxidant. They were described by Manion over a year ago. They were used to furnish current to operate lights and to run small motors. A number of other laboratories have announced similar small experimental fuel-cell systems.

After a period of experimentation, it was decided to build a commercial-size installation. The application chosen was to power a commercial wheel tractor. The chassis of a regular Allis-Chalmers D-12 tractor minus the radiator and engine was used (Fig. 1). Aluminum shelves placed in the engine compartent, as shown in Fig.2, were filled with four rows of fuel-cell units. These units consist of nine cells, each of which measures 12 x 12 x ¼ in. (Fig. 3). They are housed in epoxy resin containers. The units are connected electrically. They have tubes for gas transmission internally and with other units. The gases enter and leave through manifolds, and the electric current goes through bus bars.

Paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959, on a program arranged by the Power and Machinery Division.

The author—HARRY K. IHRIG—is vice-president in charge of research, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

*Numbers in parentheses refer to the appended references.

Acknowledgment: The author expresses his thanks to the more than thirty members of the Allis-Chalmers research staff who worked with him on the project reported in this paper.

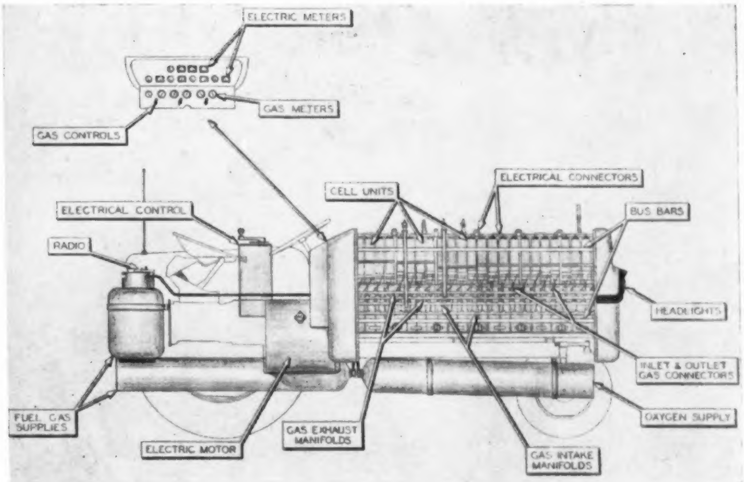


Fig. 5 Diagram shows assembled power unit designed to produce about 60 volts for operation of a 20-hp electric motor. Gases enter and leave through manifolds, and the electric current passes through bus bars

A close-up of the fuel cell power unit is shown in Fig. 4 and in the diagram, Fig. 5.

The fuel cell power plant in the tractor has 112 units which makes a total of 1008 cells. They are connected electrically in series and parallel to produce about 60 volts. The fuel cell power unit has no carburetor, air cleaner, distributor nor cooling system. In fact, it has no moving parts.

Directly behind the fuel cells is a commercial 20-hp electric motor. The current from the cells is fed to the motor through an ordinary switching-type controller (Fig. 6). This controller provides different speeds by switching on different combinations of cells and reverses the motor, Fig. 7, by reversing the polarity of the electrical current to the motor. The tractor's rear wheels are driven by a conventional shaft and differential. No change of gears is necessary to drive the tractor. Its control is entirely electrical.

The fuel is a mixture of gases. The oxidant used is bottled commercial oxygen, but cells have operated on air. The pressure of the gases was only that necessary to overcome the friction of the tubing, about 14 ounces. The temperature is ambient.

The tractor is very quiet. Only the hum of the electric motor is heard. A radio powered by fuel cell current was listened to without difficulty while the tractor was plowing. The tractor develops 3,000 ft-lb on the drawbar dynamometer test. At the 3,000 lb value the wheels began to slide. Hard dry ground with about 12 in. of alfalfa on it was plowed with a double-bottom plow without difficulty (Fig. 8). When the tractor was stopped with the plows buried in the furrow, it started again without effort when

(Continued on page 240)

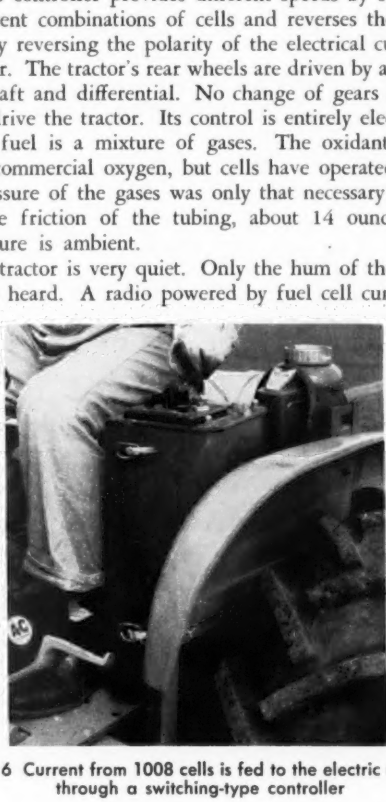


Fig. 6 Current from 1008 cells is fed to the electric motor through a switching-type controller

Fig. 7 Reversing the motor is done by reversing the polarity of the electrical current to the motor by the controller shown in Fig. 6

Fig. 8 Although still considered to be in its experimental stage, the unit develops at least 3000 lb of drawbar pull

Analysis of Forage Flow in a Deflector Elbow

William J. Chancellor and Gordon E. Laduke
Assoc. Member ASAE

Results suggest several possibilities for improvements in deflector elbow design

EXPERIENCE by many farmers as well as researchers (1)* indicates that difficulties encountered with forage flowing in an elbow have been responsible for many cases of pipe plugging and reduction of elevating capacity. The effects produced by the elbow are estimated by the following analysis.

Analysis

In formulating an analysis of material flow through an elbow, the effect of the airstream on the particle will be neglected. Most elbows are constructed with the inside part of the curve open and with the depth of the walls decreasing toward the tip. Air-velocity measurements in an elbow indicated that, in spite of the open surface, two-thirds of the high-velocity air still remained at the 180-deg point. The effect of this high-velocity air is neglected mainly because the more dense solids, on encountering the elbow curvature, are separated from the air by centrifugal action, which reduces the effect of the air on the material.

Material flow in an elbow has two stages in which friction is involved.

The first stage is the entry of the particle into the curve. An average particle coming up the center of the pipe will strike the surface of a cylindrical elbow at some angle. For a 9-in. pipe, with 3, 6, and 12-ft radius elbows, the respective angles are 29, 20, and 14 deg. The velocity reduction produced by this impact, computed as illustrated in an earlier work (3), is shown in Table 1 for a feed rate of 800 lb per min and elevation of 40 ft.

TABLE 1. INITIAL VELOCITIES ON ELBOW SURFACE
Elevation height = 40 ft; feed rate = 800 lb per min; V_e = entry velocity

	(900 rpm) $V_e = 112$ fps*			(750 rpm) $V_e = 90$ fps*			(600 rpm) $V_e = 69$ fps*		
Radius — ft	3	6	12	3	6	12	3	6	12
Coefficient of friction (f)									
0.2	86.3	97.0	102.5	69.4	78.0	82.5	53.2	59.8	63.2
0.4	75.5	88.8	97.0	60.7	71.5	78.0	46.5	54.7	59.8
0.6	61.5	80.0	90.0	49.3	64.3	72.3	37.8	49.2	55.4

*Computed in reference (4) — 3-ft diameter for impeller blower.

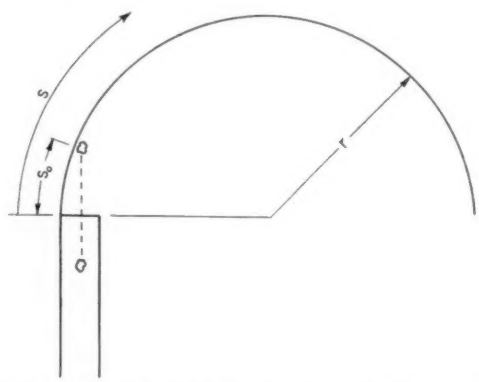


Fig. 1 Dimensions of particle movement along the elbow surface

The second stage of flow is one of gradual reduction of velocity from the frictional effect imposed by the centrifugal normal force. Fig. 1 illustrates a particle in motion in the elbow. The equation relating tangential forces at any instant is

$$\frac{d^2s}{dt^2}m + mg\cos\frac{s}{r} + f\left[\left(\frac{ds}{dt}\right)^2\frac{m}{r} - mg\sin\frac{s}{r}\right] = 0 \qquad [1]$$

in which f is the coefficient of friction, g is the acceleration of gravity, m is the mass of the particle, and t is time.

If $P = \frac{ds}{dt}$ and $\frac{dP}{dt} = P\frac{dP}{ds}$, equation [1] can be reformed as

$$\frac{dP}{ds} + \frac{f}{r}P = \left(fg\sin\frac{s}{r} - g\cos\frac{s}{r}\right)\left(\frac{1}{P}\right) \qquad [2]$$

If $P^2 = Z$ and $\frac{dZ}{ds} = 2P\frac{dP}{ds}$, equation [2] can be reformed as

$$\frac{dZ}{ds} + \frac{2f}{r}Z = 2\left(fg\sin\frac{s}{r} - g\cos\frac{s}{r}\right) \qquad [3]$$

This can then be resolved to

$$Z = P^2 = (\text{velocity})^2 = \frac{2gr\left[\left(\sin\frac{s}{r}\right)(2f^2-1) - \left(3f\cos\frac{s}{r}\right)\right]}{4f^2+1} + C\exp\left[-\frac{2fs}{r}\right] \qquad [4]$$

in which

$$C = \frac{(V_0)^2 - \frac{2gr\left[\left(\sin\frac{s_0}{r}\right)(2f^2-1) - \left(3f\cos\frac{s_0}{r}\right)\right]}{4f^2+1}}{\exp\left[-\frac{2fs_0}{r}\right]}$$

in which V_o and s_o are respectively the initial tangential velocity and the initial tangential distance of the particle as it begins to move along the surface of the elbow.

Computations were made for the 27 conditions given in Table 1. The resulting particle velocities at 90 and 180 deg are presented in Table 2 and in Fig. 2. Fig. 3 illustrates particle velocity during all parts of the elevating operation. Examination of these values indicates:

1 More energy is lost by allowing the particle to impinge on the elbow surface at some angle than by conducting it through the same angle on the elbow surface (Fig. 2).

Third part of a three-part paper presented at the Winter Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 1959, on a program arranged by the Power and Machinery Division. (The first and second parts were published in the February and March issues.)

The authors — WILLIAM J. CHANCELLOR and GORDON E. LADUKE — are, respectively, assistant agricultural engineer, University of California, Davis, and junior engineer, California Packing Corp., San Francisco, Calif.

Acknowledgment: The authors are grateful to Professor C. W. Terry, Cornell University, for his assistance and cooperation in this study.

*Numbers in parentheses refer to appended references.

TABLE 2. PARTICLE VELOCITIES IN AN ELBOW
(Feet per second)

	Elbow radius	$f=0.2$ 90 deg	$f=0.2$ 180 deg	$f=0.4$ 90 deg	$f=0.4$ 180 deg	$f=0.6$ 90 deg	$f=0.6$ 180 deg
$V_e=112$ fps	3 ft	70	52	50	30	33	18
	6 ft	75	58	54	34	38	23
	12 ft	76	62	56	39	40	30
$V_e=90$ fps.	3 ft	56	43	39	25	26	16
	6 ft	60	48	42	29	31	22
	12 ft	61	53	46	33	33	28
$V_e=69$ fps.	3 ft	42	34	30	21	20	14
	6 ft	45	38	33	25	25	20
	12 ft	45	40	34	29	26	24

V_e = entry velocity

2 In most cases more than 50 percent of the kinetic energy of the solid material is lost in a 90-deg elbow and more than 75 percent lost in a 180-deg elbow.

3 With typical conditions of $f=0.6$ and an elbow radius of 3 ft, more than 90 percent of the kinetic energy is lost in a 90-deg elbow and 96 percent in a 180-deg elbow.

4 The friction coefficient is the factor having the greatest influence on elbow performance.

5 With an increase of elbow radius, the angle at which material impinges on the elbow surface is reduced, thereby improving performance by reducing losses from impact.

Optimizing Elbow Curvature

If maximum material velocity is desired at the 180-deg point, the optimum elbow shape would be in a tight hairpin extending above the pipe outlet to a height equal to the trajectory of the material. All friction losses would be eliminated, but such an elbow would be impractical to construct and use, since height of trajectory would vary with the inlet velocity of the material.

If maximum velocity is desired at 90 deg, the material must be deflected in some manner. If equation [3] is reformed by substituting $r\,d\theta$ for ds, where θ is the angle between the radial line to the particle position and the horizontal,

$$\frac{dZ}{d\theta} + 2fZ = 2rg(f\sin\theta - \cos\theta)$$

This means that, for the decrease of the square of material velocity per incremental change of angle (for an angular increment of constant radius occurring anywhere in the elbow) to be minimum, the value of

$$2rg(f\sin\theta - \cos\theta) - 2fZ$$

should be as close to zero as possible. Since only the first term is affected by the radius, the optimum conditions will

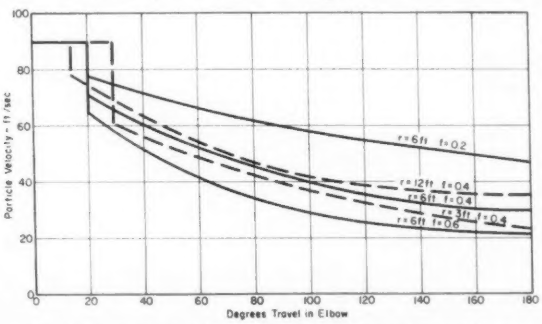


Fig. 2 Comparison of the effects of friction and radius for a particle entering the elbow at 90 ft per sec

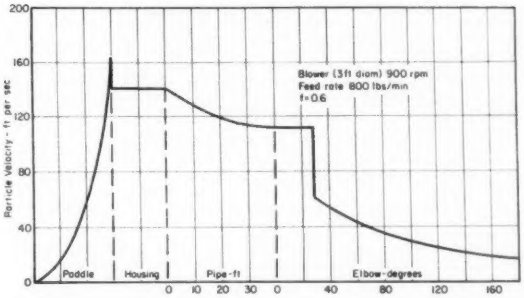


Fig. 3 Particle velocity throughout elevation by an impeller blower. Portions prior to the elbow are from references (3) and (4)

prevail where the radius r is as small as practically possible for values of $(f\sin\theta - \cos\theta)$ that are negative, and where r is as large as possible for values of $(f\sin\theta - \cos\theta)$ that are positive. This results in a very short radius elbow to the point where $\tan^{-1}\theta = 1/f$. Beyond this point the optimum elbow would really be shaped to conform to the trajectory of the solid material so that the high-velocity air could reduce any possible effects of air resistance.

If the radius of curvature is made so small that the depth of material in the elbow becomes any sizable fraction of this radius, conditions of impact (similar to impingement on a flat surface) begin to develop causing an additional energy loss.

An extremely short radius for the first section of a cylindrical elbow is impractical because not all material comes up the outside edge of the pipe; the result is large impact losses for material coming up the inside edge of the pipe. For this reason it would be better for the initial section of the elbow to be a flat section, sloping at some angle (5 to 10 deg) to the axis of the pipe, and of such length that it would cover the projected diameter of the pipe. Beyond this, a short radius of some practical value may be used up to the point where $\tan^{-1}\theta = 1/f$. This point ranges from 79 deg for $f=0.2$ to 59 deg for $f=0.6$.

Constructing an elbow to conform to the material trajectory even from 70 to 90 deg is impractical because of the large horizontal distances that may be involved and the changing of the trajectory with changes in material velocity. Therefore, the optimum radius is the largest one practical. More will be gained by increasing the radius as 180 deg is approached, but this is primarily due to the falling of the material which must be originally elevated. Ultimate modification along these lines results in the hairpin trajectory shape.

Many elbows are hinged at the 90-deg point to permit outlet at various angles between 90 and 180 deg. The impact that occurs from deflecting at intermediate angles with this type of apparatus can cause large energy losses (3). This could be improved by constructing the 90 to 180-deg section so that it may be rotated from a point on the radial line through the 90-deg point of the initial section, in a manner that would telescope the second section over the initial section, allowing a smooth transfer of material from one section to the other for all intermediate angles of deflection.

Fig. 4 shows material velocities computed for the elbows with radii of 3 and 12 ft, shown by the dashed lines in Fig. 2. These are compared with a 3-ft radius fitted with

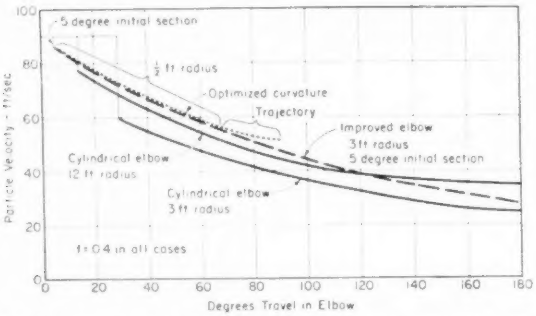


Fig. 4 Comparison of cylindrical, improved and optimized elbow curvatures for an entry velocity of 90 fps and a coefficient of friction of 0.4

a 5-deg initial section and with an optimized elbow using a 5-deg initial section, a ½-ft radius between 5 and 68 deg (68 deg is optimum for $f=0.4$), and the material trajectory between 68 and 90 deg.

Fig. 4 illustrates that the major improvement is due to the 5-deg initial section and that the optimized radius has very little effect except in the trajectory portion, where actual construction is not practical. The effect of the 12-ft radius in maintaining high velocities beyond the 68-deg point can also be seen.

Non-Uniform Flow in the Elbow

The manner in which the material becomes distributed when impinging on the elbow surface is of special significance. Evidence appearing in reference (5) indicates that the material may arrive in bunches, each probably formed by a single impeller blade. Possible distribution of these bunches is examined in the following example:

Blower (6 blade, 3-ft diameter impeller): 900 rpm

Pipe: 9-in. diameter, 40 ft high

Elbow: 9-in. wide, 3-ft radius

Material: moisture=40 percent; density=8 lb per cu ft (after impact on elbow); $f=0.6$ [Blevins (2)]

Velocity after initial impact: 61.5 fps (Table 1)

Rate of flow: 800 lb per min

The ninety 0.15-lb bunches per second may be distributed in any form having a cross section of 3.5 sq in. This form may range from a continuous stream 0.43 in. deep to bunches of short length but considerable depth.

As the material slows down in the elbow, either the bunches come closer together or a solid stream of material is formed, the depth of which must increase as flow velocity decreases.

For the example cited, the flow velocity is 18 fps at 180 deg. Therefore, at this point the bunches must have formed a stream 1.5 in. deep or have remained as bunches of an even greater depth.

If the depth assumed by each bunch as it enters the elbow is less than 1.5 in., there are two possible mechanisms by which a depth of 1.5 in. may be achieved:

1 Each bunch as it encounters a slower-moving stream of bunches tends to "pile up" as it assumes a lower velocity.

2 If the bunch does not "pile up" as it encounters a slower-moving stream, a continuous stream is formed in which flow velocity is equal to minimum velocity in the elbow. This stream, then, extends back to the elbow inlet, where the material is piled to a depth of 1.5 in. or greater as it impinges on the slow-moving stream.

Both "piling up" and impinging of solid upon solid result in some form of energy loss, and ultimately a lower minimum-flow velocity, requiring an even greater depth of material. For this reason the tendency to plug is thought to be related to the manner in which the material is distributed at the elbow inlet and to its resistance to "piling up." One of the possible reasons that plugging is not a greater problem is that, as material velocity in the elbow is reduced, centrifugal force is also reduced, making conditions more conducive to adequate piling.

Pipe Plugging

Barrington *et al* (1) encountered plugging problems under conditions very similar to those given in the example. Beyond the feed rate of 800 lb per min, plugging became unusually frequent. Several observations at the time of plugging indicated that the plug started in the elbow. Smith (6) reported that the time required for pressure build-up in the pipe indicated that the plug started some distance up the pipe beyond the pressure tap.

Several experiences by the author with pipes 40 to 50 ft high indicated that two plugs were usually formed. One was at the entry to the elbow and may extend down a foot or more, though it sometimes disappeared completely by the time the equipment could be stopped and examined. The second plug, usually more severe, occurred 15 to 25 ft above the entry to the pipe and extended downward. The distance downward was usually a function of how rapidly the feeding of material was stopped after the plug was detected.

The preceding analyses and reported tests and observations led to the following hypothesis for plug formation:

1 Rapid feeding of a material with a high "piling resistance" initiates formation of a stream of material moving at the outlet velocity. This stream develops back toward the inlet of the elbow. As the stream gains length, it slows outlet velocity, which causes a deeper, more pronounced, faster-developing, and slower-moving stream. As the final stream of great depth swells back to the inlet of the elbow, the inlet becomes restricted, reducing air outlet, which slows incoming material and completely plugs the elbow inlet.

2 The instant the elbow inlet becomes plugged, the air in the vertical pipe stops. Material impelled into the still air column is slowed to stagnation at a height above the blower that can be computed from Case I, previously discussed (4). For the example cited, this is about 20 ft. Material reaching this height accumulates to form a loose plug that grows downward. As the plug face comes closer to the impeller, the material has a higher velocity when striking the face and thus causes a more dense plug, with density being greatest of all when the plug face grows into the impeller paddles and causes wedging.

Conclusions

In many cases the capacity limit of an impeller blower (exhibited in the form of pipe plugging) is imposed by the characteristics of the deflector elbow. Even when operating at intermediate capacities, distribution characteristics of the impeller blower are impaired by high energy losses in the

(Continued on page 240)

Demand Studies in FARM ELECTRIC SERVICE

L. B. Altman and **L. F. Charity**
Member ASAE *Assoc. Member ASAE*

Load characteristics of house-heating, air-conditioning, and crop-drying applications

ELECTRIC-distribution systems serving primarily rural areas typically have annual load factors between 40 and 60 percent. This means that only half as many kilowatt-hours are delivered and used as the generation, transmission, and distribution facilities are capable of handling. As a large part of the cost of electric energy to farmers is represented in the investment in such facilities, managements of rural-distribution systems often find it desirable to evaluate the effects of electrical appliance loads upon these facilities. To help keep energy costs low, appliances are often promoted which improve system load factors through increasing energy consumption without causing a relative increase in the peak demand of the system.

The effect on distribution-system load factors of some presently used electric appliances is not fully known. To provide some of this needed information, the Farm Electrification Branch, U.S. Department of Agriculture, in cooperation with the agricultural engineering department of Iowa State University and many electric power suppliers in Iowa, has made a number of studies of the load characteristics of farm appliances (1, 2, 3)*. Among them were electric house heating, air conditioning, and crop drying.

Recording demand meters were used to record the operation of these three appliances for periods of 1 to 6 months. Load factors and other characteristics were obtained from these data. The meters used were of the block-interval type with 15-min demand intervals. Times of distribution-system demand peaks were taken from daily load curves of an Iowa generation cooperative serving a largely rural load of about 29,000 consumers.

Electric House Heating

Electric house heating is being aggressively promoted in the southern part of the United States where air conditioning has caused system annual peaks to occur in summer. In more northerly areas house heating is being encouraged by some power suppliers even though system annual peaks usually occur in winter. This load is being promoted because of its high annual energy consumption, the possibility of acquiring additional electrical load by means of having "all-electric" houses, and its relatively small demand at the time of the annual system peak. An even smaller demand at the time of the system peak may be obtained through the use of off-peak controls.

Paper presented at the Annual Meeting of the American Society of Agricultural Engineers at Ithaca, N. Y., June 1959, on a program arranged by the Electric Power and Processing Division. Approved for publication as Journal Paper No. J-3661 of the Iowa Agricultural and Home Economics Experiment Station, Ames (Project No. 1282).

The authors — L. B. ALTMAN and L. F. CHARITY — are, respectively, agricultural engineer, farm electrification research branch (AERD, ARS), USDA, Ames, Iowa, and associate professor of agricultural engineering, Iowa State University, Ames.

*Numbers in parentheses refer to the appended references.

During the 1956-57 heating season twelve electrically heated houses were metered for much of the heating season. Twenty other electrically heated houses were metered for a 4-week period in 1958. All the houses were well insulated with the equivalent of at least 6 in. of mineral wool in the ceiling, 3⅝ in. in the walls, 4 in. over unheated crawl areas, and 2 in. under floors.

All twelve houses in the first study had two-stage thermostats while the twenty houses in the second study had either single-stage or two-stage thermostats. All of the two-stage thermostats were of the low-voltage type, and the single-stage thermostats were of the line-voltage type. Off-peak controls were used in eleven of the twelve houses in the first study and in sixteen of the twenty houses in the second study. These controls reduced the heater wattage at the time of the control period by changing the voltage from 240 to 120. Other information concerning the heating systems and houses is listed in Table 1.

TABLE 1. AVERAGE CHARACTERISTICS OF ELECTRICALLY HEATED HOUSES (Iowa, 1956-58)

	Number metered	Floor area, sq ft	Connected heating load, kw	Maximum 15-min demand, kw	Annual energy consumption, kwh
Study No. 1	12	1,373	14.8	11.8	16,303
Study No. 2	20	1,497	15.6	11.2	16,854

Study No. 1

The average daily load curve with the highest demand during the study for house-heating systems with off-peak controls and two-stage thermostats is shown in Fig. 1. Represented in this curve are the eight heating systems from which data were suitable for tabulation. Also shown is the daily load curve of a rural electric distribution system which had demands on the same day almost as high as the annual maximum demand.

The small demand of the heating systems during the control period and the large demand immediately following this period may be quoted. This artificial peak resulted from less heat being supplied during the control period than was required to satisfy the thermostats. It may be calculated that an artificial distribution-system peak would have been created after the control period if electric house-heating saturations had exceeded approximately 5 percent (4). A different saturation percentage would be required to create an artificial peak if a different shaped distribution-system load curve had been used.

The annual load factors of the twelve individual heating systems averaged 15.9 percent, a little less than typical well-equipped farms. The group annual load factor averaged 18.9 percent with the maximum demand occurring shortly after the system peak. If off-peak controls had not been used, computations indicate that the group annual load

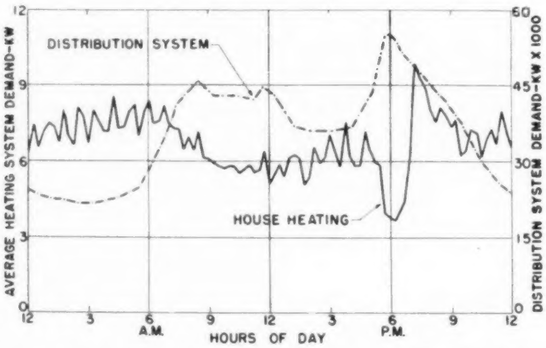


Fig. 1 Average demands of eight electric house heating systems and a rural distribution system. Iowa, January 16, 1957

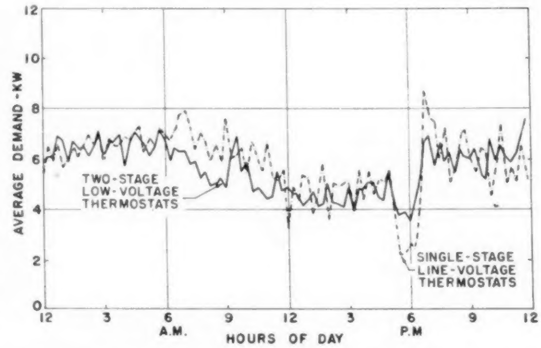


Fig. 2 Average demands of six electric heating systems in Iowa using single-stage thermostats and 10 systems using two-stage thermostats. February 8, 1958

factor would have been 21.9 percent with the group maximum demand occurring in the early morning. The demand at the time of the system peak, however, would have been greater than for the heating systems with off-peak controls.

The group demand at the time of the distribution-system peak is of particular significance to the cost of electric energy. The group annual load factor based on this demand was 50.3 percent for heating systems with off-peak controls and would have been about 31 percent if controls had not been used.

House-heating systems without off-peak controls will have an adverse effect on the annual load factor of a system with a winter demand peak. Under the same conditions and with limited saturation of this load, off-peak controls will improve slightly, if at all, the system annual load factor. If a saturation is reached where the system annual peak occurs after the control period, any additional controlled or uncontrolled heating systems would then lower annual system load factors. For a distribution system with a summer annual peak, electric house heating will improve the annual load factor.

Study No. 2

The effect on system annual load factor of the type of thermostat used with heating systems having off-peak controls was determined from data obtained in the 1958 study. Sixteen of the twenty heating systems metered used off-peak controls. Of these, ten used two-stage thermostats, and six used single-stage thermostats.

In cold weather the heating systems with two-stage thermostats operate on 120 or 240 volts when connected. Under the same conditions the heating systems with single-stage thermostats operate on 240 volts when connected. With either arrangement only the heaters operating on 240 volts just before the control period are immediately affected by the reduction to 120 volts brought about by the off-peak controls. The average annual energy consumptions of the two groups of heating systems were about the same in this study; therefore, the average requirement for heat at any one time should be about the same for heating systems with either type thermostat. This indicates that heating systems with single-stage thermostats had more heaters operating on 240 volts just before the control period and thus were affected to a greater extent by the change in voltage caused by the off-peak controls than were those systems with two-stage thermostats.

Fig. 2 shows the average daily load curves of heating systems with the two types of thermostats for the coldest day of the metering period. The minimum temperature for this day, February 8, 1958, was −11 F. The shapes of the curves during the control period were largely influenced by two variables: first, the requirements for heat caused thermostats that were open at the start of the control period to close at various times during the off-peak period; second, the duration and timing of the control periods were not coordinated. If all open thermostats had closed at the same time and if the control periods had been identical, the demand during the control period would have resulted in horizontal lines on the load curves. It can also be seen in Fig. 2 that, although the demands were about the same before the control period, the average heating-system demand with two-stage thermostats dropped to 3.56 kw during the control period as compared to 2.20 kw for those with single-stage thermostats.

Metering was not continued for the entire heating season as the average of the recorded demands during the control period on the coldest day during metering was expected to be very close to the actual heat-system demand at the time of the distribution-system annual peak. Using this measured peak value in calculations, the six houses with single-stage thermostats had a group annual load factor of 73.6 percent, while those with two-stage thermostats had 55.8 percent. In weather colder than experienced in this study, it could be expected that demands during the control period of heating systems with single-stage thermostats would be higher than those metered, and those with two-stage thermostats would be about the same. This would reduce somewhat the group annual load factors of heating systems with single-stage thermostats.

Air Conditioners

The demands of 15 air conditioners were metered between July 1 and August 22, 1958. Twelve of these were of the window type and three were of the central type. The window air conditioners averaged 1.1 hp in size and the central-type units averaged 3.7 hp.

Fig. 3 shows the average daily load curve for the fifteen air conditioners for August 9. On this day the 92 F tem-

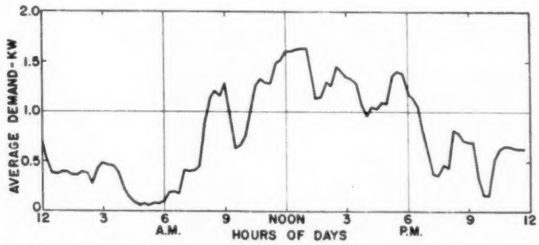


Fig. 3 Average demand of motors on 15 air conditioners in Iowa. August 9, 1958

perature in central Iowa was the highest recorded during the metering period. This was several degrees less than the expected maximum summer temperature. Since all units were operating at this relatively low temperature, it is concluded that there is practically no diversity in time of peak use of air conditioners—that is, all air conditioners may be expected to be in use at the same time.

Distribution-system summer peak demands ordinarily occur just before noon in Iowa. Although air-conditioner demand is very high at this time of day, it may be considered a favorable load from an annual-load-factor viewpoint. The reasons are that typical summer distribution-system demand peaks are only about two-thirds of winter peaks, also, that considerable energy is consumed.

Actual annual load factors for air-conditioning equipment could not be calculated because metering was limited to only a part of the air-conditioning season. Energy consumption for 30-day periods during the metering interval averaged 750 kw-hr for central units and 260 kw-hr for the window units.

Demand-meter records clearly showed that the motors on the window air conditioners did not cycle on their thermostats. This was the result of the following two factors: The units were too small for the space conditioned and/or the occupants did not start the units until a considerable heat load was already in the house. Under the latter conditions the units did not have the capacity to reduce the temperatures sufficiently for them to cycle. Two of the twelve owners indicated that they tried to cool the entire house with a window unit. All but three cooled two or more rooms with single window units. Those units for one room only were of ½ or ¾-hp size.

It is not surprising, in view of the above usual method of operation, that nearly 50 percent of the owners stated that they should have purchased a larger unit. There were no reports of lamps dimming when air-conditioner motors started, probably because ten of the twelve units were on special circuits and the units did not cycle.

Two of the three central air conditioners cycled on their thermostats although the frequencies of cycling of these two were considerably different. The 5-hp unit usually ran for periods of 1½ to 3 hr and then was off for ¾ to 1½ hr. The probable causes of this were that the thermostat had too wide a differential or was improperly located. One 3-hp unit ran for at least a part of every 15-min period on warm days. The other 3-hp unit was installed in a house of 2300 sq ft floor area and operated continuously during warm weather. This unit was obviously undersize.

Crop Driers

The demands of twenty crop driers were metered during the fall of 1958. These were evenly divided between heated and natural-air driers. Of the ten heated-air driers, five were LP gas fired and five burned fuel oil. Four of the ten heated-air driers were of the batch type and were used with shelled corn. The remaining six were of the bin type, three for shelled corn and three for ear corn. Only one of the natural-air driers was used with shelled corn while the other nine were used with ear corn. The motors for the heated-air driers averaged 5.3 hp in size and 6.4 hp for the natural-air driers.

For the corn-drying season, energy consumption for the heated-air driers averaged 742 kw-hr while the natural-air driers averaged 1,073 kw-hr. Five of the natural-air driers were also used for drying hay. It was estimated that each had an average energy consumption of 1600 kw-hr for this purpose. The annual load factors of the twenty individual driers averaged 2.98 percent, and the group annual load factor was 4.32 percent.

Energy consumption for crop-drier use during the fall of 1958 was probably low because of the unusually favorable field-drying conditions. Most of the farmers chose to delay harvest during this weather and thus placed relatively low-moisture corn in the drying units. In some cases part of the crop was dried to a safe storage moisture content in the field.

Less favorable drying conditions in 1958 would have resulted in more corn being dried, in higher-moisture corn being placed in the driers, and thus in larger numbers of driers in operation at one time. The actual conditions, however, caused the driers to be used at varying times and for short periods, resulting in a diversity factor of 1.79. As a point of interest, one farmer had finished drying by October 17, while most of the others had not started harvest until after this date.

By October 30, five of the farmers had completed drying for the season. On this day, eleven of the remaining fifteen driers were operated. The average daily curve for this date based on these driers is shown in Fig. 4. It may be noted that drier demands were high between 7 a.m. and 5 p.m. Only one heated and two natural-air driers were operated throughout the night. All of the driers, however, except those of the batch type, were operated during some of the nights of the drying season.

Even though crop driers have low annual load factors, they will improve the annual load factors of distribution systems with winter demand peaks. This is, of course, because the equipment is used in the summer and fall when system demands are low. Distribution systems with summer

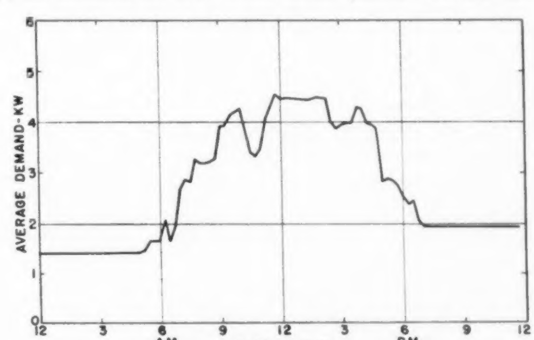


Fig. 4 Average demand of 15 motors on grain driers in Iowa. October 30, 1958

. . . Farm Electric Service

peaks could expect system annual load factors to be reduced if crop driers are used for small grains and hay.

Although a crop drier may be considered a desirable load by some power suppliers and undesirable by others, it can have one disadvantage for any power supplier; that is, an increase in transformer capacity is usually required. An intensification of this problem was reported when, on one system, there were several instances of a single crop drier being used on two or more farms during the drying season. In most of these cases, larger transformers had to be installed on each farm. Crop drier loads, in that they usually run continuously for several days, are considerably different from many other farm-motor loads with similar power requirements, such as elevators, barn cleaners, and silo unloaders. These loads are usually on a short-duty cycle and can utilize the high short-time overload capacity of transformers.

Summary and Conclusions

A study was made of the load characteristics of electric house heating, air conditioners, and crop driers. The probable effects of the demands of these appliances on the annual load factors of rural electric distribution systems were determined. Data recorded in this study showed the usual method of operation of this equipment.

Electric house-heating systems wihout off-peak controls may be expected to reduce system annual load factors when system peak demands occur in winter. Off-peak-controlled house heating should change very little, if at all, the annual load factors for distribution systems with winter peaks up to saturations where artificial peaks are created at the end of the control periods. Distribution systems with summer peak demands will benefit from electric house heating regardless of whether or not off-peak controls are used. Heating systems with off-peak controls and single-stage thermostats were found to improve system load factors more than those with two-stage thermostats.

Air conditioners would improve load factors of distribution systems with winter peaks and reduce those of systems with summer peaks. Demand-meter records showed that there is almost no diversity in the time of operation of air conditioners. These records also indicate that the operation of window air conditioners was such that cycling on the thermostat did not occur.

Crop driers improved the annual load factors of distribution systems with winter peaks. They may also improve load factors of systems with summer peaks if fall-maturing crops are dried. When used for drying corn during the fall of 1958, crop driers had a diversity factor of 1.79. Crop driers require a large transformer to serve a load which may operate only a relatively few days during the year.

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. . . An Electric-Powered Tractor

(Continued from page 233)

the current was turned on. Tests indicate efficiencies of 50 to 60 percent with this first model. It is believed this can be increased to efficiencies of 70 to 80 percent or over twice that of any heat engine.

The exhaust consists largely of water. On the experimental tractor this is exhausted through two one-half-inch tubes on the front of the cell units. Some of the gases are not utilized for power but sweep out the water. In a commercial vehicle the gas would be recirculated and condensation equipment would remove the water.

Another feature of the fuel-cell power unit is that it does not have to be installed all in one place. The units can be operated so long as they are connected with wires for the electric current and tubes to transmit the gases. Motors could be installed in each wheel of a large vehicle.

Although the tractor described in this paper is a research vehicle, it may be the pioneer in fuel-cell tractors and other vehicles such as automobiles, trucks, and locomotives. With the possibility of much higher efficiencies and lower fuel costs, many other applications will be made with fuel-cell power units. Thus an electric drive is possible without storage batteries or generators.

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. . . Analysis of Forage Flow

(Continued from page 236)

elbow. The analysis presented here suggests several possibilities for improvements of the deflector elbow:

1 An initial section of small angular change from the pipe axis would tend to reduce friction losses occurring in the impact of the material with the elbow surface.

2 Surface materials of low friction coefficient would improve performance, particularly with moist or partially dried forage.

3 An elbow cross section designed to become progressively wider may reduce plugging during high-capacity operation.

4 Plugging might also be reduced and distribution characteristics improved by the addition of energy to the material in the elbow. This energy might come from an outside source or from the kinetic energy of the high-velocity air.

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(Left) A homesteader's cabin in Matanuska Valley of Alaska • *(Right)* Cleared agricultural land in the Matanuska Valley south of Palmer

Engineering in Alaska Agriculture

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Member ASAE

Land of midnight sun poses challenging problems for agricultural engineers

TO understand some of Alaska's agricultural engineering problems, it is first necessary to review certain climatic and geographical facts. Alaska has a land area one-fifth the size of the first 48 states, which is larger than the combined areas of Norway, Sweden, California, and Washington. Nearly enough area is left over to equal New England. Within this tremendous area live 220,000 people, fewer than in Spokane County. Of this 220,000 population, almost 130,000 live in the metropolitan environs of Anchorage and Fairbanks, both cities being located on the Alaska Railroad near large military installations. It is estimated that there are approximately 35,000 Indians and Eskimos in Alaska, which leaves about 55,000 white people scattered throughout the remaining 586,000 square miles of the area. It is a spectacular country of high mountains, great rivers, and almost limitless areas for which, at the moment, there seems to be little economic use except recreation.

Agricultural production at present comes from 21,500 acres of cleared land, which comprises only 0.005 percent of the land area of Alaska. If all the potential agricultural land was used, 0.25 percent of the total land area would be planted and about one percent would be grazed. At present the major farm areas are the Matanuska and Tanana Valleys which are conveniently located to provide agricultural products for the railbelt population.

Mountain ranges dominate Alaska, there being five major ranges and several smaller ones. The Yukon River and its tributaries comprise its largest drainage system. Next in size is the Kuskokwim. There is almost no agricultural development along these rivers, except in the Tanana Valley in which Fairbanks is situated. Nearly two-thirds of Alaska's agricultural production is in the Matanuska Valley. This is so small that it hardly shows on the map. At present there is some homesteading activity in the Susitna River drainage. This is a large area, quite close to Anchorage, and on the railroad which passes through the valley.

There are great variations in climatic conditions with the Juneau, Sitka, Ketchikan area having weather somewhat like Seattle. The weather in the Anchorage-Palmer area has been compared with Trondheim, Norway. Frost-free periods for the Matanuska and Tanana Valleys are practically the same — about 100 days. A brief study of climate records for some of the northern states shows there are only a few places with such a short-growing period. For example, in Logan, N. D., the frost-free period is 108 days, and in Florence, Wis., 107 days.

During the period when crops are growing there can be 17 to 21 hours of sunshine at Anchorage and Fairbanks, respectively. That total radiation is somewhat less intense at these latitudes is indicated by the fact that in 1956 Matanuska received 20 percent less than Madison, Wis., during the period May to August inclusive, even though there were many more hours of daylight. Prolonged daylight compensates for the short calendar growing period, and it is therefore possible to raise most cool-season vegetable and many forage and grain crops. When compared on the basis of degree-days, Alaskan towns are somewhat colder than the coldest in the South '48. Degree-days are 11,000 and 14,000 for Palmer and Fairbanks, respectively. In contrast Spokane rates a 6,300 figure and Duluth, Minn. 9,770.

At the present time there are about 200 fulltime commercial farms in Alaska, with 300 to 400 part-time farms and possibly 4,000 homesteads. The average size farm in the Matanuska Valley is about 260 acres, with 65 acres of cropland per farm.

Farmer's Economic Position

The Alaskan economy is not and has never been dependent on agriculture for support. Farming is accepted like any other business and has had to stand on its own feet. The only crop eligible for a support price is wool, which con-

Paper presented at a meeting of the Pacific Northwest Section of the American Society of Agricultural Engineers at Ephrata, Wash., October 1959.

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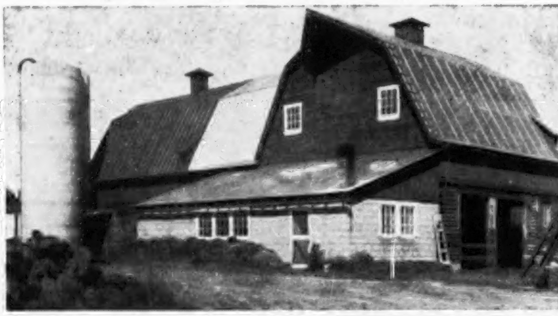

(Left) Pen-type barn made by joining two colony-type barns in the Matanuska Valley (Alaska) • *(Right)* Harvesting lettuce near Palmer, Alaska

tributes but a small amount toward the farm income. This year cereal grains will come under a federal loan program at prices well below the going commercial rates.

Alaskan farmers must contend with these limiting economic factors: high production costs and high capital requirements, insufficient long-term low-interest capital, a limited market, intensive competition from well-organized marketing areas, and a challenging climate.

High production costs result from a composite of higher unit costs. Some of these are larger investments in land, buildings and machinery; higher costs for fertlizer, seed, and supplies, and much higher labor costs. To obtain labor farmers have had to take those who cannot or will not take construction work, since farm wages cannot compete with rates paid for seasonal labor on military construction projects. Fertilizer costs are also a large factor. Our soils require from 200 to 400 pounds of mixed fertilizer for field crops and from 600 to 1,000 pounds per acre for vegetables. Mixed commercial fertilizer costs about $7.00 per hundred weight delivered in Palmer. The cost of other goods the farmer must buy is reflected in the cost-of-living index. For 1958 it was quoted as 140.8 for Anchorage, with Seattle representing 100. As would be expected in this "high cost" area, the cost of farmstead development is one and a half to two times that of the farming areas with which Alaskan farmers compete for markets.

Marketing is "Bottleneck"

Marketing the farm products seems to be the farmer's biggest headache. Less than 15 percent of the food consumed in Alaska is produced locally. Prices paid to the farmer by civilian stores are usually based upon Seattle prices plus freight. Unless this happens to be air freight, it does not provide him with much margin. The armed forces and their dependents purchase 60 to 70 percent of the potatoes and vegetables and perhaps 20 percent of the fresh milk sold in Alaska. These purchases are made using normal government-bid procedure, with individual farmers competing with the one principal organized marketing facility. For two years this has resulted in potato prices that are no more than cost of production.

One facet of the problem is the tendency of some vegetable crops such as lettuce and cabbage to mature at nearly the same time. For a brief period there is an unlimited supply. Methods are needed to extend the period when fresh vegetables can be sold.

Grade A milk accounted for almost half of all agricultural sales in 1958. Potatoes ranked second, with about one quarter of the sales. The remainder was equally divided between poultry, fresh vegetables, and animal products.

To succeed without off-farm income the Alaskan farmer must have a reasonably large operation. The following is an estimate for present conditions, along with an average requirement for capital:

Type of Farm	Minimum unit	Annual production	Capital required
Dairy	20 milking cows	200,000 lb	$40,000 - 50,000
Potatoes	15 to 20 acres	90 to 120 tons	35,000 - 45,000
Poultry	3,000 laying hens	50-60 thousand dozen	30,000 - 40,000
Grain	250 to 300 acres	180-225 tons	40,000 - 50,000

Research Tackles Problem

Agriculture is a small industry in Alaska, and farmers are faced with unusually difficult problems. It is fortunate that Congress and the U. S. Department of Agriculture through the Agricultural Research Service have instituted a research program to seek answers while the industry is still small.

Work in agricultural engineering was started in 1948 when A. D. Edgar spent several months in the territory working particularly on problems of potato storages. The first full-time agricultural engineer was added to the staff in 1949.

Structural Concepts for Cold Weather

Farming in Alaska is a high-cost operation. It seemed important to undertake research that might reveal major cost savings. One of the most obvious major costs is farmstead building construction. The first project started in

Irrigation research is used for determining water requirements of bromegrass pasture

agricultural engineering was concerned with methods of using native materials for farm construction. Spruce lumber sawed locally sells for $80 per thousand, compared to $130 for shiplap and dimension material. There are several sawmills that will saw lumber for one-half enabling a homesteader to obtain lumber, if he has time, equipment and a supply of logs.

Regardless of materials used, a good vapor barrier is an essential element of a structure in a climate such as the Matanuska Valley. Both sawdust and pulverized moss are suitable insulation for farm structures when properly used. A full-sized house was designed by the U. S. Public Health Service and built at Aniak, using principles developed under this project. It has been most satisfactory.

Observations incidental to this work proved a "cold roof" is needed in the climatic conditions of central Alaska. The first and foremost reason for a roof is to shed water, snow, sparks, and any other falling material, thus maintaining the permanence of the structure below. In most conventional plans, roofs have become building components with a dual role, that of conserving heat as well as its primary function. In most of Alaska a roof is most satisfactory when limited to its primary function. Two most serious problems with roofs arise from heat leakage from the building, and from moisture vapor which originates in the structure beneath. Moisture vapor builds up ice on the underside of the sheathing which subsequently melts when outside temperatures rise. Heat leakage to roofs produces ice dams. Differences in melting rates in various areas of the roof result in ice build-up on eaves and valleys. These problems are eliminated with a functional cold roof.

There are two principles involved in a cold roof design: *(a)* heated areas are isolated by adequate insulating material and an effective vapor barrier, and *(b)* roofs are deliberately ventilated from the underside with cold air to keep the roof surface below 32 F.

Some investigations of the physical properties of soil from several Eskimo villages where there is no timber are being started, in the hope of finding a way to build houses from stabilized earth blocks. Probably half of our 35,000 native population live in housing that we would not recommend for livestock. They do not possess the economic capability to construct homes of conventional materials.

The machine which may prove suitable is a hand-operated press called "cinva-ram," built in Columbia, South America. A dirt block 3¾ in. high by 5⅜ in. wide by 11⅜ in. long is produced. The blocks can be made of soil and will probably be satisfactory for building material. Constructing an economical and practical footing suitable for use in the areas in which such structures will be located is a problem that we have not yet solved. Locations are all in permanently frozen ground. Most materials must be transported either by air or by boat during a short summer period.

Loose Housing of Dairy Cattle

Reducing farmstead capital requirements has been effectively accomplished by enterprise management changes. The outstanding example of this is the rapid change throughout the country to loose housing for dairy cattle. Whether or not loose housing management is adapted to all agricultural areas of Alaska is a question we need to answer. We can say "Yes" for the Matanuska Valley, but we are dubious concerning areas as cold as the Tanana Valley.

At Fairbanks, an area where the ground temperatures average below freezing, loose-housing bedded areas do not stay warm from normal fermentation processes. This year we are installing a small heating coil under the bedded area of a loose-housing barn to investigate the cost and desirability of adding sufficient heat to keep the bedded area in active fermentation. If it works it will provide a normal bedded area. The addition of a small amount of heat to the bedded area may make that system entirely practical in the Tanana Valley of Alaska, and we feel that we have no cause to be concerned about the development of dairy herds in areas more cold than this.

Pole-Type Construction

Every agricultural engineer is aware of the wide application of pole-frame construction to dairy buildings. Most plans specify poles treated with preservatives. Pressure-treated poles are quite expensive in the Matanuska Valley, costing approximately $1 per foot of length. Since many areas of Alaska have timber stands from which poles can be taken, it seems important to find methods of treatment that can be used on the farm.

Over 500 treated fence posts and poles are under observation at our Matanuska station. For treating longer poles needed in farm-building construction, we have used three methods which work satisfactorily. They are the tire-tube method, the bored-hole method, and a method of spraying which was developed and tried at the Matanuska farm.

In the spray method, freshly peeled green poles are placed nearly vertical in a wooden tank of treating solution. A plastic chamber is erected around the poles and the treating solution is recirculated, being pumped out of the tank in which the posts are standing and sprayed over the posts under treatment. The method and equipment can be applied to poles at least 20 ft in length. Results to date indicate that all four common varieties of local trees—spruce, cottonwood, poplar, and birch—can be used for fence posts if treated. Poplar and cottonwood take the treatment readily and make fairly good posts, although they are not useful for most other purposes.

One unusual Alaskan problem is the destruction of farm fences by moose during the winter. This is not a problem in the spring and summer when they move to higher elevations. In at least one capacity the moose perform a service to farmers, they are reasonably effective in keeping brush eaten down.

Clearing the Land

Clearing land is one of the most difficult and persistent problems confronting the homesteader. Homestead requirements generally demand that 20 acres per 160 acres homesteaded be cleared within a 3-year period. This costs the farmers from $3,000 to $5,000 depending on how heavy the cover is, the size of equipment available, and the efficiency of the particular operator. Farmers have been able to get some assistance with clearing through cost sharing of about $40 per acre available through the agricultural conservation program.

Studies conducted on land clearing for several years have not revealed any method which is radically different or cheaper. Each type of timber cover presents a somewhat different situation. In general, bull dozing is the standard method of clearing and all types of blades are used. Best clearing has been done with dozers equipped with the root

rakes. Their main advantage is that there is less dirt piled into the windrows. This facilitates burning and enables farmers to dispose of the windrows somewhat more quickly.

In the Fairbanks area tree cover in many areas is considerably lighter than in the Matanuska Valley, and land clearing costs much less. A method of partial clearing, involving shearing with an angle dozer and broadcast burning, has been used extensively in the last two years. On one particular combination of cover (small spruce and moss) some good results have been obtained. After these processes it is necessary to use a heavy breaking disk, such as the Rome bush-and-bog harrow, and to do a considerable amount of root picking. The most effective means is a dozer equipped with a root rake.

Testing Specialized Farm Machinery

The experiment station has purchased and tried out several pieces of land-clearing equipment including a bush-and-bog harrow, a Hoover land-clearing shear, a special root rake made in Edmonton, and a new root picker manufactured by Lockwood Graders. The Rome disk is an effective tool. To do good work it requires a track-type tractor equivalent to a Cat D4. After working with a Rome disk, a field can be finished with a heavy farm disk and planted. Many roots remain, some of which can be windrowed with a machine such as the Edmonton root picker. After windrowing it is necessary to load them into a truck and remove them from the field.

The Lockwood root picker has been used one season. It works quite well utilizing a four-man crew. In working old windrows, per acre operating costs were approximately $150. It is the most promising piece of trash-removal equipment we have seen. One device which was built to assist in the burning of windrows is a skid-mounted airplane motor. Many run-out airplane motors are available and can be equipped for approximately $250. It is an effective device, permitting a farmer to burn cleaner and also to operate during periods of unfavorable weather.

Irrigation Research

Increasing production per acre has the same effect as reducing land-clearing costs. Sprinkler irrigation of crops has been under investigation in the Matanuska Valley for four years. Furrow irrigation is largely impractical because soil mantles are quite thin—from 12 to 24 in. in many places—and also because many fields are too uneven to level.

The water requirement of bromegrass, timothy and potatoes is between 10½ and 13 in. per season, although normal rainfall during the period is only 7½ in. in the Tanana Valley and 9½ in. in the Matanuska Valley, obviously inadequate to meet the demand. There is almost no rainfall in the months of May and June when grain, forage and vegetables require moisture for seed germination.

Much snowfall is not effective in replenishing soil moisture, since the ground is solidly frozen in the spring until after the snow cover melts. In the Matanuska Valley snow seldom remains more than a couple of weeks at a time, as it is frequently moved by high winds.

In 1956, thermocouples were placed in the ground at various depths and soil temperatures observed in irrigated and non-irrigated areas. It was found that the irrigated areas were as much as 6 deg cooler than the non-irrigated. This temperature difference could easily result from the additional transpiration of the crop receiving supplemental water.

Irrigation definitely has a place in the agricultural picture of Alaska. Research is underway to determine the most economical rates of fertilizer application and proper pasture management under irrigated conditions.

Drying and Storing Cereal Grains

A most rewarding study is that of the storage and preservation of cereal grains. The moisture content of grain harvested in Alaska is such that artificial drying is required. In 1957, the Matanuska Valley Farmers Cooperating Association constructed a drier and grain-storage facility in Palmer. This provided a market outlet for barley and oats for the first time in Alaska. Additional equipment was added to grind and mix local feeds. At the present time this plant is manufacturing at least 75 percent of the Alaskan feed requirements and is using as much local grain as is available in these feed mixes.

The experiment station had been conducting research on the drying and storage of cereal grains for five years prior to this time. Under our climatic conditions barley and oats, with an initial moisture content of 18 percent, can be stored in farm bins. Barley and oats with an initial moisture content of 28 percent have been held in aerated bins, ventilated with a suction system with an air flow of 3 cfm per bushel of grain. To date the production of cereal grains has primarily been oats and barley. A little wheat is also grown.

Prefabricated Metal Buildings

Prefabricated metal buildings seem to offer a real saving for Alaska farmers. As an example, a recent steel building erected by the Matanuska Valley Fair Board cost $2.03 per square foot in place. This was without a concrete floor. Two insulated steel buildings erected under government contract by the experiment station have cost $10.00 per square foot with a concrete floor. A simple wood-frame barn constructed this year on concrete footings and with a concrete floor cost $20 per square foot. Architects often use a figure of $30 per square foot for completed residential construction.

Labor-saving machinery is readily accepted on the established farms in the Matanuska Valley. Dairy farmers are now changing to single-cut, flail-type harvesters. Having the proper machinery and a sufficient amount of it is very important in Alaska because of the brief harvesting season where all operations may be stopped by the weather at any time after the middle of October.

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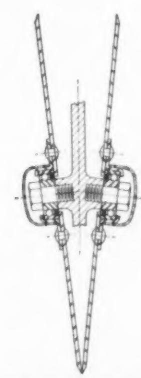


Fafnir Plya-Seal Ball Bearings for disc grain drills are available with one seal or two seals.

ASAE Officers for 1960-61

The following new officers of the American Society of Agricultural Engineers were elected as a result of the regular election conducted by letter ballot of its corporate members, and will take office along with L. W. Hurlbut, who automatically advances from president-elect to president, at the close of the Society's Annual Meeting to be held on the campus of Ohio State University, Columbus, June 12-16.

President-Elect — **Byron T. Virtue,** vice-president of engineering, The Torrington Co., Torrington, Conn.

Vice-President — **S. M. Henderson,** agricultural engineering department, University of California, Davis.

Councilors — **F. W. Andrew,** extension agricultural engineer, University of Illinois, Urbana (Electric Power and Processing Division); **J. R. Carreker,** research liaison representative, Soil Conservation Service, USDA, Athens, Ga. (Soil and Water Division).

Nominating Committee — **A. C. Dale** (chairman), professor of agricultural engineering Purdue University, Lafayette, Ind.; **G. M. Eveleth,** chief engineer, Rock Island Works, J. I. Case Co., Rock Island, Ill.; **R. W. Kleis,** head, agricultural engineering dept., University of Massachusetts, Amherst; **F. W. Peikert,** head, agricultural engineering department, Pennsylvania State University, University Park; **J. G. Sutton,** drainage engineering specialist, engineering division, Soil Conservation Service, USDA, Washington, D. C.

In June the Council of ASAE will be increased from 10 to 11 members and will consist of the newly-elected officers and the following: L. W. Hurlbut, president; J. W. Borden and E. W. Schroeder, past-presidents; and H. H. Nuernberger and A. W. Cooper, councilors. As president-elect, Byron Virtue will automatically succeed L. W. Hurlbut as president of ASAE in June 1961.

Members of the Society are invited to send to any member of the Nominating Committee such suggestions as they may have for nominees for election of officers of the Society in the next annual election of officers, which will be held early in 1961. It is desirable that such suggestions reach the Nominating Committee on or before June 1, 1960.

BULLETIN

As the Journal goes to press word has been received that Lewis A. Jones, former head of drainage investigations for the Soil Conservation Service, USDA, and ASAE Life Fellow, died on March 24. Further details will be carried in May issue.

ASAE Tractive and Transport Efficiency Committee Meets

The ASAE Tractive and Transport Efficiency Committee, which is made up of representatives from five tire companies, (including the Pirelli Co., Milan, Italy), seven farm machinery companies, three state research agencies, and two federal research agencies, held a meeting March 9 and 10 at the National Tillage Machinery Laboratory in Auburn, Ala. The objectives of the Committee are: *(a)* to establish a common language by preparing a glossary of definitions of terms used in the field of traction and transport; *(b)* to serve as an agency for accumulating, consolidating, and dispensing information on tractive and transport equipment; and *(c)* to make suggestions for new research work in the field of traction and transport based on problems as they arise and are recognized by the Committee.

Reports given at the meeting included: One on the development of radial ply banded tractor tires from the Pirelli Co.; one of tests on six tractor tires; one on the tire testing program of the Tractor and Implement Division, Ford Motor Co.; and one on soil and tire parameters. Other items discussed in detail were further tests on rolling resistance, variables to be investigated, the definitions of slip, rolling radius, and travel reduction. A movie was also shown on buckling in conventional and radial ply tires made at the National Tillage Machinery Laboratory.

Agricultural Engineering Day at Kansas State University

The theme for Kansas State University's Agricultural Engineering Day, to be held at Ahearn Field House on April 29, is "Farm Feed Handling," and the program has been planned to feature the feed handling problem for on-the-farm feeding of poultry and livestock. It has been organized to be of special interest to both farmers and equipment dealers by the KSU Agricultural Engineering Department in cooperation with the Extension Engineering Dept., Continuing Education Dept., Agricultural Economics Dept., Kansas Electrification Council, Western Retail Implement and Hardware Assn., *Implement and Tractor Magazine, Kansas Farmer Magazine,* and WIBW Radio and TV.

Equipment displays and exhibits may be visited before and after the programs.

NIAE Open Days

The National Institute of Agricultural Engineering, Bedfordshire, England, will hold Open Days on May 11 and 12. On these two days visitors have an opportunity to observe the NIAE testing program in its entirety. Exhibits are arranged under departmental headings and for the sake of convenience are sited where the work is generally carried out. The program will include examples of measuring recording instruments designed and built for NIAE and other facilities for tractor, implement and machinery testing.

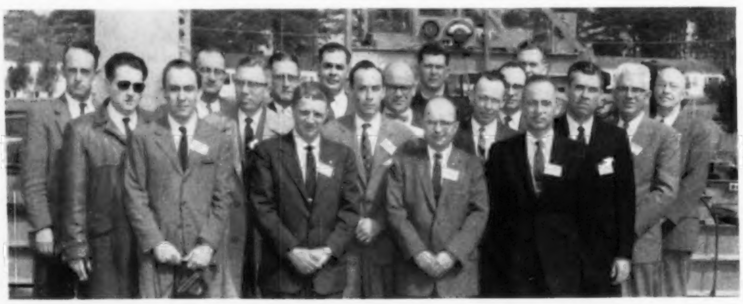
(Continued on page 262)

Events Calendar

(See page 261)

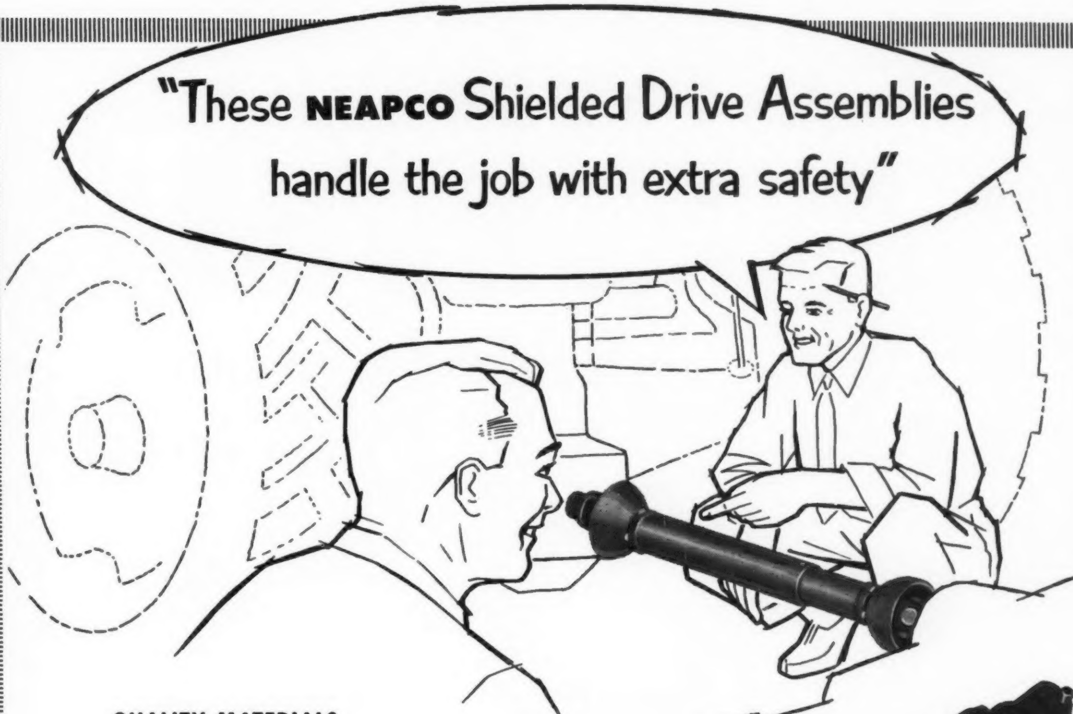
ASAE Committee Activity

Representatives from tire companies, farm machinery companies, state research agencies, and federal research agencies, as members of the ASAE Tractive and Transport Efficiency Committee, met March 9 and 10 at USDA National Tillage Machinery Laboratory, Auburn, Ala.



Above *(left to right)* D. W. Tanner, NIAE, Silsoe, England; Z. Janosi, Army Ordnance Land Locomotion Laboratory, Detroit, Mich.; M. A. DeGiorgis, Pirelli Co., New York City; C. B. Richey, Ford Motor Co., Birmingham, Mich.; R. S. Reaves, Allis-Chalmers Co., Milwaukee, Wis.; J. W. Seiple, John Deere Tractor Research and Engineering Center, Waterloo, Iowa; R. N. Coleman, International Harvester Co., Hinsdale, Ill.; S. J. Knight, Waterways Experiment Station, Corps of Engineers, Vicksburg, Miss.; A. Cegnar, Pirelli Co., Milan, Italy; H. B. Hindin, U.S. Rubber Co., Detroit, Mich. *(back)* D. R. Freitag, Waterways Experiment Station, Corps of Engineers, Vicksburg, Miss.; *(front)* K. E. Hohnl, J. I. Case Co., Racine, Wis.; P. J. Forrest, U.S. Rubber Co., Detroit, Mich.; T. J. Thaden, The Goodyear Tire and Rubber Co., Akron, Ohio; *(back)* A. W. Cooper, National Tillage Machinery Laboratory, Auburn, Ala.; *(front)* J. M. Hooper, B. F. Goodrich Co., Akron, Ohio; R. L. Wann, The Firestone Tire & Rubber Co., Akron, Ohio; and I. F. Reed and M. L. Nichols, National Tillage Machinery Laboratory, Auburn, Ala.

Right *(left to right)* C. B. Richey, vice-chairman; A. W. Cooper, chairman; A. Cegnar, and Z. Janosi



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Lester G. Kopp


Robert C. Morrow


James N. Dill


George E. Womble

Lester K. Kopp recently has accepted the position of chief engineer with Wain-Roy Corp., Fitchburg, Mass., manufacturer of construction equipment.

Robert C. Morrow, agricultural engineer with the American Planter Co., has been appointed manager of Michigan Farm Structures, a newly formed subsidiary of American Planter Co. Mr. Morrow is an agricultural engineering graduate of Iowa State University and has had widespread experience and interest in farmstead planning and automation.

James N. Dill, formerly assistant to vice-president of sales at Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y., recently has been appointed to the company's newly-created position of special products sales manager. His duties will include evaluation of market potentials, development of specifications, establishment of production points and stock levels, sizes and types, pricing, and sales promotion. He joined the company as a sales representative in the Midwest in 1946 and was transferred to Port Chester headquarters in 1955.

George E. Womble has joined the product engineering staff at the Rockford Works of the J. I. Case Co. as product engineer and division head in charge of material handling. Prior to this change he was engineering supervisor at the New Idea Division of Avco Corp., Coldwater, Ohio.

Clayton J. Schwartz recently has been appointed eastern manager of *Electricity On The Farm Magazine*. He formerly was its midwestern advertising manager in Chicago.
Gene B. Parker, who was formerly an agricultural sales representative for Indiana and Michigan Electric Co., Muncie, Ind., has been appointed midwestern representative.

NECROLOGY

Noel H. Miller passed away on March 15 after a short illness. He had been associated with the Modine Manufacturing Co., Racine, Wis., for the past 33 years and was western sales manager for its Automotive Division at the time of his death. In 1926, he received a B.S. degree in Mechanical Engineering from the Massachusetts Institute of Technology, and was well known throughout the agricultural and automotive industries. He was a member of the Society of Automotive Engineers and of the Modine 30-Year Veterans Club, as well as ASAE. Surviving are his widow, one daughter and three sons.


Noel H. Miller

George Shute is now located in Toronto, Canada, with Massey-Ferguson Ltd. in the position of product planning manager. He was previously located in Chicago, Ill., where he was a farm practice research analyst with International Harvester Co.

George B. Bradshaw advises that he is now project manager for International Engineering Co. in Port-au-Prince, Haiti. He formerly was associated with Morrison-Knudsen Afghanistan, Inc.

Bernard A. Gehl, who was formerly a project engineer with Dempster Mill Mfg. Co., now holds the position of design engineer with The Oliver Corp. in South Bend, Ind.

Kenneth S. Kordik advises that he is now employed by Jacobsen Manufacturing Co. of Racine, Wis., as design engineer. He formerly was connected with Le Tourneau-Westinghouse Co. as product engineer.

Mark F. Reinbold is now located in Portland, Ore., with J. I. Case Co. as assistant branch service manager. He previously was associated with the Irrigation Experiment Station at Washington State College, Prosser.

Reginald S. White, who was a design engineer with Hilbe Engineering, Inc., now holds the position of design and sales engineer with Redi-Rain Mfg. Co., Inc., Glendora, Calif.

Walter M. Ashley, formerly with Babco Builders, Inc., has accepted a position with International Harvester Co., Hinsdale, Ill., as a product designer.

Chauncey W. Smith spent a part of January and February in Georgia, working with G. E. Henderson on the manuscript for a vocational teaching guide on "Tractor Maintenance." The manuscript is planned for publication by the Southern Association of Agricultural Engineering and Vocational Agriculture. While in the south, he also managed a side trip into the orange-producing area of Florida.

R. William Nelson is now connected with geochemical and geophysical research, chemical effluents technology, chemical research and development at the Hanford Laboratories Operation of General Electric Co. at Richland, Wash. He formerly was associated with Colorado State University at Fort Collins.

Norman Kraeft, farm editor of WGN Radio and Television, was guest of honor recently at a luncheon in Washington, D.C., hosted by Senators Paul Douglas and Milton Young. He presented a report on farmers' earnings to a group of bi-partisan farm state Senators on the results of his meetings with major farm organizations in several mid-western states.

Paul M. Mulliken will retire as executive vice-president of the National Retail Farm Equipment Association on June 30, 1960, at which time he will have completed 20 years as the managing head of the organization. When he joined the organization in 1940 as executive secretary, it consisted of 3,452 members in 16 affiliated associations. Now there are more than 13,000 members in 34 associations. Under his leadership NRFEA has developed many management aids and services, including a uniform bookkeeping system for farm equipment retailers; *Farm and Power Equipment,* the monthly magazine; an improved Official Tractor and Equipment Guide, a Farm Equipment Retailer's Handbook; the Annual Cost of Doing Business Study, and the NRFEA Insurance Service, Inc.

Marvin J. Samuelson advises that he has accepted the position of laboratory supervisor with McCulloch Corp., Minneapolis, Minn. He previously was chief experiment engineer with the Tractor Division of Minneapolis-Moline Co., Hopkins, Minn.

Loyd Johnson advises that he is now located in Almirante, Panama, where he is employed by the Chiriqui Land Co. He formerly was associated with Cia Agricola de Guatamala, Tiquisate, Guatamala.

Edwin K. Bonner, Jr., formerly chief engineer with S. L. Allen Co., has accepted a position with Crown Marking Equipment Co., Philadelphia, Pa., as superintendent.

David L. Brown has accepted a position as gear engineer for Steel Products Engineering Co., Division of Kelsey-Hayes, Springfield, Ohio. Previously, he held the position of design engineer with Oliver Corp.

William J. Napier advises that he is new zone manager for Southern Ford Tractor Corp., New Orleans, La. He formerly held the position of industrial sales manager with Universal Tractor Equipment Corp.

Lester L. Nighswonger, who formerly was a design engineer with Beech Aircraft Corp., has accepted a position as senior engineer with John Deere Research and Engineering Center, Waterloo, Iowa.

A. N. Gibson has accepted a U.S.A. Technical Cooperation Mission to New Delhi, India. He previously held the position of agricultural engineer with the Soil Conservation Service, USDA.

Peter J. Clifford advises that he is now located in Fowler, Calif., with the Goble Disc Division of Massey-Ferguson Inc. as a project engineer. He was previously with H. D. Hume Co., Mendota, Ill., as a project engineer.

Pacific Coast Section

The Pacific Coast Section will hold its Annual Meeting on April 14 and 15 at Arrowhead Conference Center, University of California, Lake Arrowhead. Activities will begin on Thursday morning with a general session. The address of welcome will be given by D. G. Aldrich, Jr., dean of agriculture, University of California. L. H. Skromme, chief engineer, New Holland Machine Division, Sperry Rand Corp., and president of ASAE, will speak on our space age frontiers. To complete this session talks will be given on the financial and managerial situation in regard to agricultural shares, and political aspects of water development.

The Thursday afternoon program will be a general technical session and will include discussions on a whole new world of comfort by year-round air conditioning, recent developments in water law, root plowing and range reseeding, economic and financial aspects of water development in California, motor vehicles as a source of air polution, and plastics in soil and water conservation. DeWitt Nelson, director, water resources department, State of California, will be the guest speaker at the annual banquet scheduled for Thursday evening. His topic will be "Development of California's Natural Resources for Recreation."

The Friday morning meetings will consist of two concurrent sessions. The Power and Machinery Division will hear discussions on labor saving techniques in the Los Angeles egg market, chemical and mechanical weed control in irrigated cotton, white-cap conditioned-air system, the Rotoscan grain separator, boom-hoist system for handling citrus fruits, and mechanical egg handling equipment. Papers to be presented during the Soil and Water Division session will cover the following subjects: Influence of high water table on forage crops; laboratory calibration of irrigation turnout gated; TV down the hole on channel H_2O; engineering research at the Southwest Water Conservation Laboratory; cavitation in centrifugal pumps; and sub-irrigation of small plots with ceramic water wicks.

The two-day program will be concluded with the annual business meeting on Friday afternoon.

The Engineering Education Seminar will be held April 15 and 16, opening on Friday afternoon with a session on teaching techniques and procedures. Two concurrent sessions will be held on Friday evening: One on organizations related to or affecting engineering education; and the other on agricultural engineering preparation for vocational agricultural teachers. K. K. Barnes, professor of agricultural engineering, University of Arizona; J. L. Butt, executive secretary, ASAE, St. Joseph, Mich.; M. V. Johnson, Jr., chief engineer, research department, engineering division, Sunkist Growers; J. F. Merson, head, agricultural engineering department, California State Polytechnic College, San Luis Obispo; and Michael O'Brien, agricultural engineering lecturer, University of California, Davis, are among those who will participate in the Saturday morning session on engineering education and curricula trends.

Firestone Tire and Rubber Co. served as host for Ohio Section meeting, February 27. *(Left to right)* R. L. Wann, manager of tractor tire development, explains tire construction to Ohio Section officers, G. O. Schwab, secretary-treasurer, C. L. Hahn, chairman, and R. P. Harbage, past-chairman

Ohio Section

More than 70 members attended the Ohio Section meeting on February 27 at Akron, Ohio. The meeting was sponsored by Firestone Tire and Rubber Co. and arranged by R. L. Wann, manager, Tractor Tire Development. The program included a movie, "The Building of a Tire," followed by a tour of the tire plant, research laboratory, and exposition building. A luncheon was provided at the new Firestone Country Club. Following the business meeting, K. L. Campbell, manager, truck and off-the-highway tire engineering, Firestone Tire and Rubber Co., presented an excellent talk on tire materials and design — present and future. A paper was also given on the general agricultural outlook by J. T. Cahoon, manager, marketing research department, Firestone Tire and Rubber Co. Brochures and tire ash trays were given as souvenirs.

North Carolina Section

The North Carolina Section held its Winter Meeting on February 26 at the Agricultural Engineering Department on the campus of North Carolina State College, with 58 in attendance. A stimulating talk on the Research Triangle Institute and agricultural industry was presented by H. W. Hunter of the Research Triangle Institute, Durham, N. C. Rounding out the program were talks on grass vs. mechanical harvesting of cotton, machinery needs in the conservation program, use of weather bureau data for estimating water availability, the future design of farm buildings, end environmental effects on human performance. During the business meeting the following new officers were elected for the coming year: Chairman, J. M. Fore, professor, agricultural engineering dept., North Carolina State College, Raleigh; first vice-chairman, P. M. Wagoner, Wagwood Farms, Gibsonville, N. C.; second vice-chairman, H. D. Bowen, associate professor, agricultural engineering dept., North Carolina State College, Raleigh; and secretary-treasurer, J. W. Dickens, AMS, USDA, agricultural engineering dept., North Carolina State College, Raleigh.

Many of the members took advantage of the opportunity to attend the Symposium, "Ideas for Equipment," which was held on February 25 and sponsored by the North Carolina Section. The purpose of the Symposium was to present a review of research accomplishments for advancing agriculture and the industries which serve it, primarily in and around North Carolina.

ASAE MEETINGS CALENDAR

April 14-15 — Pacific Coast Section, Arrowhead Conference Center of the University of California.

April 22 — Quad City Section, American Legion Club, Moline, Ill.

April 27 — Chicago Section, Embers Restaurant, Madison, Wis.

April 29 — Iowa Section, Tallcorn Hotel, Marshalltown, Iowa

May 5-7 — Florida Section, Ellinor Village, Ormond Beach, Fla.

May 6 — Michigan Section, Oliver Co., Battle Creek, Mich.

June 12-16—Annual Meeting, Ohio State University, Columbus, Ohio.

August 22-23—North Atlantic Section, University of Massachusetts, Amherst.

October 19-22 — Pacific Northwest Section, Empress Hotel, Victoria, B.C., Canada.

Note: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Hawaii Section

The Hawaii Section held its annual dinner meeting on March 3 in the Kauai Room, Princess Kaiulani Hotel, with 32 in attendance. During the business meeting held after the dinner the following officers for 1960 were elected: Chairman, H. R. Cerny, California Packing Corp.; vice-chairman, Eugene Morgan, American Factors, Ltd.; and secretary-treasurer, Jaw-kai Wang, University of Hawaii. Following the business meeting J. F. Cykler presented color-slides taken on his trip to Mexico during a sabbatical leave two years ago.

Right, newly-elected officers of the North Carolina Section *(left to right)* J. M. Fore, chairman; P. M. Wagoner, first vice-chairman; H. D. Bowen, second vice-chairman; and J. W. Dickens, secretary-treasurer

TECHNICAL PAPER ABSTRACTS

Following are brief reviews of papers presented at ASAE meetings or other agricultural engineering papers of which complete copies are available. ASAE members may obtain copies of these papers without charge by returning order forms supplied upon payment of membership dues. Non-members, and members requesting more than 10 copies, may purchase papers at 50 cents each to cover carrying charges from the American Society of Agricultural Engineers, St. Joseph, Mich.

A Gas Turbine Crop Dryer, by Donnell R. Hunt, associate professor of agricultural engineering, Iowa State University, Paper presented at the Winter Meeting of ASAE at Chicago, Ill., December 1959, on a program arranged jointly by the Electric Power and Processing and Power and Machinery Divisions. Paper No. **59-618.**

This paper is a report of an investigation made into the use of a low output gas turbine, and an inductor for possible application as a high-capacity, heated-air, crop dryer. Included in the paper is an analysis which shows how the continuity equation, general energy equation, momentum equation, and the perfect gas laws were used to derive an equation of eight variables relating inductor entrance and outlet conditions. These variables were also related to the primary-final weight rate of flow ratio. The paper also tells how the development of the gas turbine was accomplished by adding a stainless steel combustion chamber to a turbo-supercharger, and by sealing and fitting the exhaust chamber of the supercharger with a nozzle that terminated in the inlet of the inductor's mixing tube.

Testing procedures to evaluate the use of the theoretical analysis for the inductor action are also given, plus the test results which indicated close agreement between the derived equations and the measured values.

Farm Application of Thin Shell Concrete Roofs, by Earl R. Bell, extension specialist, rural buildings, Oklahoma State University, Stillwater. Paper presented at the Winter Meeting of the ASAE, at Chicago, Ill., December 1959, on a program arranged by the Farm Structures Division. Paper No. **59-806.**

The shell theory for building construction in the United States reportedly gained acceptance during World War II. There were a few commercial structures before then but they were really not thought of as feasible at the time. The shell principle calls for only a rigid exterior skin and all support, as well as structure, is in the skin. There is no interior skeleton. Reinforced concrete before this, had been used in imitation of other materials in the traditional beam, column, and arch. In the shell process it was finally given a continuous molded structural form to fit the basic plasticity of concrete itself. If a concrete thin-shell is thin enough in relation to its radius (less than 1/50 to 1/300 of radius) it is said to produce a structure highly economical in materials and is capable of supporting heavy loads with a minimum of bending or twisting stresses. This paper explains the farm application of the thin-shell structure and refers to 24 slides which were used with the presentation to describe and illustrate the shapes and possible uses of concrete thin-shell in farm buildings.

Thermoelectric Cooling and Power Generation, by C. S. Duncan, research engineer, Westinghouse Research Laboratories, Pittsburgh, Pa. Paper presented at the Winter Meeting of ASAE at Chicago, Ill., December 1959, on a program arranged by the Farm Structures Division. Paper No. **59-808.**

The intent of this paper is to acquaint the agricultural engineer with a new kind of apparatus now entering the commercial scene. Because of recently developed materials and device technology, thermoelectric cooling and electric power generation are becoming competitive with conventional methods. It presents a brief history of thermoelectricity, discusses the basic principles of operation and device engineering considerations. Present day devices and future expectations are also covered.

Predicting Sediment Production and Deposition for the Design of Soil and Water Conservation Structures, by A. F. Geiger, geologist, Central Technical Unit, Soil Conservation Service, USDA, Beltsville, Md. Paper presented at the Winter Meeting of ASAE at Chicago, Ill., December 1959, on a program arranged by the Soil and Water Division. Paper No. **59-703.**

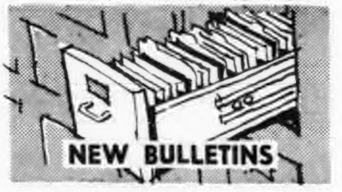
Sediment deposition is one of the most important items entering into the cost of maintenance of soil and water conservation structures. Predictions of the expected volume of sediment which will be delivered to and trapped by any given conservation structure may enable the engineer to provide for sediment storage or to decrease the tendency of the structure to trap sediment. This will decrease maintenance and increase the effective life of the structure. Predictions of sediment deposition can be based on the amount of erosion; the type of sediment produced; the rate of delivery of sediment to the structure, and the ability of the structure to hold the delivered sediment. Possible methods of computing or estimating these factors under various conditions and their influence on sediment production are presented.

Critical Tractive Forces in Cohesive Soils, by Ernest T. Smerdon and Robert P. Beasley, respectively, associate professor of agricultural engineering, Agricultural and Mechanical College of Texas, College Station, and professor of agricultural engineering, University of Missouri, Columbia. Paper presented at the Winter Meeting of ASAE at Chicago, Ill., December 1959, on a program arranged by the Soil and Water Division. Paper No. **59-702.**

The problem of the stability of open channels is of great importance in any field of engineering concerned with the design of open channel water conveyance systems. This paper presents a brief resume of the tractive force theory and its method of application to the problem of stable open channel design. The critical tractive force was determined by two methods. One method evaluates the forces that must act on any free body of water within the channel and the other gives the tractive force at a fluid boundary in terms of the velocity gradient at the boundary. The results appear not to be the same, but a definite correlation exists between the values obtained by the two methods. In order to determine some basic relationships between critical tractive force and the physical properties of cohesive soils a series of tests were conducted, including physical tests on the soils to determine their physical properties and hydraulic tests to determine the critical tractive force.

Effect of Design Factors of Disks on Soil Reactions, by William F. McCreery, agricultural engineer, National Tillage Machinery Laboratory, Agricultural Research Service, USDA, Auburn, Ala. Paper presented at the Winter Meeting of ASAE at Chicago, Ill., December 1959, on a program arranged by the Power and Machinery Division. Paper No. **59-622.**

Although disk harrows have been made for many years, very little technical information relative to their design has been published. This paper, which is a progress report, discusses the preliminary results from a study of disk design factors made at USDA National Tillage Machinery Laboratory, at Auburn, Ala. The disks used in the study were divided into two groups; one with a constant radius of curvature and various diameters; and the other with a constant diameter and various radii of curvature. All of these disks have the "standard" type 1 edge, which is beveled on the outside. Disks having the same dimensions as some of those above, but with the type 7 edge (beveled and ground on the inside) were included for a comparison of edge types. All comparative test runs were made in Lakeland sand, at a speed of 2.5 mph. Each disk was run at prescribed settings of angle, depth, and width of cut, and the forces acting on the disk were measured in three mutually perpendicular directions as draft, vertical, and lateral forces. This report shows that the settings and the design factors of disks influence the forces acting on the implement in operation.



The following bulletins have been released recently. Copies may be obtained by writing to author or institution listed with each.

The following articles are reprints from the *Quarterly Bulletin,* Vol. 42, No. 2, November 1959, of the Michigan Agricultural Experiment Station, Michigan State University, East Lansing, and are available from this source:

Article 42-48 — Pages 323 to 330, *"The Effectiveness of Water Use in Sprinkler Irrigation for Frost Protection,"* by H. von Pogrell and E. H. Kidder.

Article 42-31 — Pages 350 to 372, *"An Analysis of the Particle Board Process,"* by Otto Suchsland.

Article 42-34 — Pages 393 to 400, *"Drop Size Distribution from a Medium Pressure Irrigation Sprinkler,"* by Paul E. Schleusener and E. H. Kidder.

Article 42-37 — Pages 428 to 433, *"The Effect of Varying Temperatures, Application Rates and Spraying Frequencies on Leaf Runoff Under Simulated Radiation Frost Conditions,* by H. von Pogrell and E. H. Kidder.

The following test reports may be obtained from the Province of Saskatchewan, Agricultural Machinery Administration, 7th and Hamilton St., Regina, Saskatchewan, Canada:

No. 1459 — *Report on Wear of Cultivator Sweeps (16-in.)*

No. 1559 — *Report on Test of Tox-O-Wik Grain Drier, Model 250 (Functional Test Only)*

No. 1659 — *Report on Test of Cropgard Grain Drier, Model Super 40 (Functional Test Only)*

No. 1759 — *Report on Test of John Deere Grain Drier, Model No. 458 (Functional Test Only)*

No. 1859 — *Report on Test of Habco Grain Drier, "200" Recirculating (Functional Test Only)*

No. 1959 — *Report on Test of New Holland Grain Drier, Model 735 (Functional Test Only)*

No. 2059 — *Report on Farm Tractors, 1959*

Vermiculite Fire-Resistance Ratings. December 1959. AIA File 21-C-1. May be obtained from Vermiculite Institute, 208 S. LaSalle St., Chicago 4, Ill.

Mechanizing Your Feeding Operations, by D. W. Works. Farm Electrification Leaflet No. 48, December 1959. Extension Division, College of Agriculture, University of Idaho, Moscow.

Increasing Potato-Harvester Efficiency, by A. H. Glaves and G. W. French. Agriculture Handbook No. 171. May be obtained from the U.S. Government Printing Office, Washington 25, D.C. Price, 15 cents.

Agricultural Aviation. Quarterly Bulletin. Published by European Agricultural Aviation Centre, le v. d. Boschstraat 4, The Hague, Netherlands. Subscription rate, $3.50 per year.

Choose Your Career in Agriculture. Available from W. D. Hoard & Sons Co., Fort Atkinson, Wis.

The Shape of Raindrops, by Douglas M. A. Jones. Circular 77, 1959. Available from State of Illinois, Illinois State Water Survey Division, Urbana, Ill.

School Shop Safety. OE-84003, Circular No. 609. Trade and Industrial Education Branch, Division of Vocational Education, U.S. Department of Health, Education, and Welfare, Washington 25, D.C.

Landbauforschung Volkenrode. Third Quarterkissue (July-December), 1959. Mitteilungsblatt der Forschungsanstalt fur Landwirtschaft, Braunschweig - Volkenrode, Germany.

Precision Farm Planning. Published by *The Progressive Farmer,* Birmingham 2, Ala.

Electric Heating Devices for Winter, by D. W. Works. Farm Electrification Leaflet No. 47. September 1959. Extension Division, College of Agriculture, University of Idaho, Moscow.

NEW FILM RELEASES

A Look at Soviet Agriculture. 16mm. 18 min. Color and sound. Distributed by United World Films, Inc., Government Department, 1445 Park Ave., New York 29, N. Y.

At Home with Wood. 16mm. 13 min. Color and sound. Distributed by United World Films, Inc., Government Department, 1445 Park Ave., New York 29, N. Y.

How Grass Grows. 16mm. 11 min. Color and sound. May be obtained from New Holland Machine Co., New Holland, Pa.

Rotary Tillers in Action. 16mm. 20 min. Color and sound. For film contact Mr. Long-Price, Howard Rotavator Co., Inc., Harvard, Ill. No charge to farm groups.

Double Seal Ball Valve Design. Slide film. 20 min. Color and sound. For information contact Maxwell H. Reck, assistant sales manager, Jamesbury Corp., Worcester, Mass.

The Greatest Milking Hand. 16mm. 21 min. Color and sound, by DeLaval Separator Co. Available from Modern Talking Picture Service, 3 E. 54th St., New York 22, N. Y.

New Concept in Big Tractor Power Shift Transmission. 11 min. Color and sound. Contact Caterpillar Tractor Co., Peoria, Ill., for information.

How to Fertilize Corn. 35mm. 17 min. Color strip film. To obtain a print, address Allied Chemical Corp., Nitrogen Division, Film Library, Dept. HFC, 40 Rector St., New York 6, N. Y.

MANUFACTURERS' LITERATURE

Literature listed below may be obtained by writing the manufacturer.

Farm Machinery Brochure
New Idea Farm Equipment Co., Coldwater, Ohio — Colorful brochure describes and illustrates company's complete line of farm machinery and also includes its new products — full trailing mower with 10-ft cutter bar and 10-ft hay rake.

Tractor and Equipment Catalog
International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill.—An 82-page catalog describes and illustrates in color the complete line of 1960 McCormick and International tractors and equipment.

Sprocket Line Booklet
Dodge Manufacturing Corp., Mishawaka, Ind. — Bulletin A691, 56 pages, describes and illustrates company's expanded line of roller chains, which includes single-strand, double-strand, double-pitch-drive and conveyor, and standard attachments. Taper-lock sprockets, steel plate and bored-to-size sprockets are also listed together with weld-on hubs and taper-lock bushings for special requirements. Calculation of center distances, horsepower ratings, conveyor engineering, and instructions for lubrication and maintenance are included.

Diesel-Powered Electric Plants
Kohler Co., Kohler, Wis. — An 8-page booklet entitled "The Kohler Trio" describes and illustrates a series of diesel engine powered electric plants (the 2000, 5000, and 7500-watt plants) for marine, railroad and industrial markets. Included in the booklet are the standard equipment needed and model specifications for each plant.

Tractors, Farm Loaders and Drills
Allis-Chalmers Manufacturing Co., Milwaukee 1, Wis.—Publication of three pieces of literature is announced:

Catalog No. TL-2183, a 12-page, 4-color illustrated brochure is entitled "Big-Stik Power" and tells briefly the story of the D-17, D-14, D-12 and D-10 tractors and implements, as well as hay tools.

Bulletin No. TL-2190, a 4-page illustrated brochure is entitled "Heavy Duty Farm Loaders" and covers Models 17, 14, and 9 farm loaders for the D-17, D-14, and WD and WD-45 tractors.

Catalog No. TL-2110, a 16-page, 2-color, illustrated brochure is entitled "All-Crop Drills" and describes the seven all-crop drill models.

Chain Data Book
S. G. Taylor Chain Co., Inc., Hammond, Ind. — Bulletin 59, a 28-page chain sample book, illustrates most sizes of 17 types of welded and weldless chain. Actual size illustrations, recommended uses, and working load limits for each size are given.

5-Plow Tractor
Minneapolis-Moline Co., Hopkins, Minn. — A 2-color, illustrated brochure describes in detail the Model M5 tractor with the full 5-plow power. Included are engine and tractor specifications.

Diesel Brochure
GM Diesel, Detroit Diesel Engine Division, General Motors Corp., 13400 W. Outer Drive, Detroit 28, Mich.—An 8-page, 4-color illustrated brochure, entitled "GM Diesel Powers the Most Productive Farm Tractors in the World." It gives complete specifications on current tractors powered by the company's engines, including information on optional and extra equipment.

Hydraulic Check Valves
Parker Hydraulics Division, Parker-Hannifin Corp., 17325 Euclid Ave., Cleveland 12, Ohio — Catalog File sheets 1562A14 and 1562A15 describes hydraulic check valves for 3000 psi operating pressure for in-line mounting, with internal pipe thread connecting port in one end and "triple-lok" machining on the other end for flared-tube connection.

Bearing Units
Browning Manufacturing Co., Maysville, Ky. — A 20-page catalog, No. BU-103-A, contains detailed specifications and illustrations of a variety of pillow and flange blocks, and take-up units. Also included are load rating and comparison charts.

Hard Coat Aluminum
Toro Manufacturing Corp., 3042 Snelling Ave., S., Minneapolis, Minn.—Literature on a new way to hard coat aluminum parts said to be 10 to 50 times faster than conventional methods. The new method electrochemically produces on the surface of the metal a film of aluminum oxide whose degree of hardness reportedly places it in the range of diamonds, sapphires, and rubies.

Ball Bearing Manual
Nice Ball Bearing Co., Division of Channing Corp., 30th and Hunting Park Ave., Philadelphia 40, Pa.— An engineering manual of ball bearings for farm machinery, Catalog FM100, is divided into such special categories as flange bearings, belt and chain idlers, cam followers, PTO bearings, plunger bearings and wire guides. Also included is a listing of radial bearings adapted to farm machinery applications.

Pressure-Lock Filter Elements

Purolator Products, Inc., Department 132, Rahway, N. J. — 4-page folder describes a type of hydraulic and pneumatic light-in-weight filter element free of "built-in" contaminants giving detailed information on the pressure-locking process. Specifications for five types of elements covering rated flow capacities of 0.5, 3, 6, 12, and 24 gpm, plus details on degree of filtration, temperature range, construction materials, fluids, and minimum collapse pressure, are included in the folder.

Propeller Water Meters

Measure-Rite, Inc., 701 S. Garfield Ave., Alhambra, Calif. — A 4-page, 2-color bulletin, No. MR-100, describes and illustrates several models of propeller meters for irrigation and low pressure systems (working pressures up to 75 lb). Also included are detailed specifications.

Oil Cooler Catalog

Young Radiator Co., Racine, Wis. — A 10-page, 2-color oil cooler catalog lists complete data on oil-to-air and oil-to-water oil coolers for torque converters, industrial applications and marine transmissions.

Conveyors and Vibrating Feeders

Link-Belt Company, Dept. PR, Prudential Plaza, Chicago 1, Ill. — A 76-page book, No. 2989, entitled "Screw Conveyors and Screw Feeders" describes and illustrates over 20 different types of screws, 14 types of troughs (with 4 types of covers), 5 types of discharge openings and two types of feeders. It shows how screw conveyors are used for conveying and elevating, distributing, reclaiming, collecting, mixing, blending, agitating, aerating, heating, and cooling materials. Also included is an extensive list of materials for which the conveyors may be used.

A 12-page book, No. 2869, entitled "MC Vibrating Feeders" describes and illustrates complete line of motorized counterweight vibrating feeders — more than 60 sizes. Selection and application information is given on feeders in all size ranges.

Ball and Roller Bearings

Hoover Ball and Bearing Co., Bearing Division, 5400 S. State Road, Ann Arbor, Mich. — 4-page Bulletin 112 describes and illustrates two new series of ball bearings — one with inch dimensions (R series), and the other with metric dimensions (30 series). It also includes dimension, load, and other application information.

A 16-page bulletin, No. 113 illustrates and describes the company's various spherical roller bearings with super finish rollers and raceways. Dimensions, rated radial load capacity, and load ratings are also given for each series.

Testing Equipment

Soiltest, Inc., 4711 W. North Ave., Chicago 39, Ill. — 316-page 1960 Engineering Testing Equipment Catalog is illustrated and indexed and includes equipment for soils, concrete testing, aggregates, bituminous testing, mobile testing laboratories, road roughness indicator, drill and sampling, as well as general.

Replacement Motor Catalog

O.E.M. Products Co., 5296 Northwest Highway, Chicago, Ill. — The 1960 Automotive Replacement Motor catalog lists a complete line of universal and custom made motors built to car-makers' specifications, including the following types: Defroster, air conditioner, seat actuator, top lift, axle shift, trunk lid and window lift motors. Also included are easy-to-read listings; a handy conversion chart for quick reference; and instructions for ordering tailor-made motors.

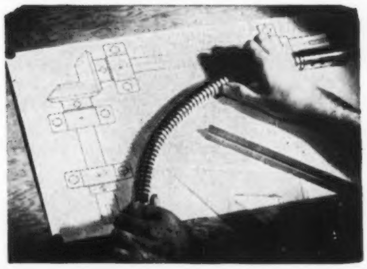
ADVANTAGES OF FLEXIBLE SHAFTING

For Power Drive and Remote Control

by C. HOTCHKISS, JR.

Application Engineer,

Stow Manufacturing Company



Flexible shafting has the following advantages over other type drives:

1—It is often the simplest method of transmitting power between two points which are not collinear or which have relative motion

2—eliminates exposed revolving parts

3—does not require accurate alignment

4—easy to install and maintain.

RELATIVE MOTION—Where two shafts which have relative motion must be connected, flexible shafting is often the ideal means of transmission. In many cases it eliminates a much more complicated drive which would, necessarily, include telescopic joints; further, it eliminates the danger of exposed moving parts. See figure 2, which shows a $\frac{3}{4}$-inch Stow flexible shaft driving an Avery Rake built by the Minneapolis Moline Co.

NOT COLLINEAR—Where it is necessary to connect two shafts which are not collinear, a simple arrangement of a single belt or two universal joints will often do the job adequately. But, in many cases where the path of transmission is more complicated and would require a more expensive arrangement of mechanical components, flexible shafting provides a simple, low cost, efficient drive which is easy to install because it does not require accurate alignment. See example, figure 1, in which a $1\frac{1}{4}$-inch Stow flexible shaft is used to drive the auger on a G.L.F. bulk feed truck.

Flexible shafting also allows the designer greater freedom in locating either the drive or the driven component on a piece of equipment.

Fig. 2

Fig. 1

Other typical applications of this type are used on portable power tools when motors are too heavy to be mounted on the tool—such as portable grinders, sanders, paint scrapers, saws and tree tappers. And, since flexible shafting is not affected by vibration, it is an ideal drive for applications where a high degree of vibration is involved — such as in vibration testing tables and concrete vibrators.

Stow flexible shafts are available: for power drive applications in diameter sizes from $\frac{1}{8}$ inch to $1\frac{1}{4}$ inches; for remote control applications in diameter sizes from $\frac{1}{8}$ inch to $1\frac{5}{8}$ inches.

The $1\frac{1}{4}$ inch power drive shaft will transmit up to 10 HP while the $1\frac{5}{8}$ inch remote control shaft will transmit up to 4000 lb. in.

For complete engineering data on flexible shafting, including selection charts, write for engineering bulletin 570.

STOW MANUFACTURING COMPANY

39 SHEAR STREET • BINGHAMTON, NEW YORK

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Byars, George H. — Agr. engr., res. stations div., agr. dept., North Carolina State College, Raleigh, N. C.

Brenn, Bailey L. — Farm sales rep., Connecticut Light and Power Co., King St., Thompsonville, Conn.

Bulba, Elias — Res. engr., agr. eng. dept., Technion Res. and Dev. Foundation, Israel Institute of Technology, P.O. Box 4910, Haifa, Israel

Cooper, George H. — Owner, Glade & Grove Supply Co., P.O. Box 198, Princeton, Fla.

Gerst, Adolph H. — Eng. checker, J. I. Case Co. (Mail) Box 79, R. 2, Burlington, Iowa

Goyal, Hukam C. — Soil conserv. engr., dept. of agr., Government of U.P., India, Rehmankhera, Kakori, Lucknow, India

Hoverstad, Herbert H. — John Deere Co., 800 Washington Ave., N., Minneapolis, Minn.

Hyman, Charles M. — Product engr., International Harvester Co., East Moline, Ill.

Kyle, Donald E. — Maint. supt., Alfalfa Div., Archer-Daniels-Midland Co., Box 60, Neodesha, Kans.

Matthes, Jr., Ralph K. — Res. asst., agr. eng. dept., North Carolina State College, Raleigh, N. C.

Maxwell, Brian G. J. — Sales rep., B. C. Tractor Equipment Ltd. (Mail) 1905 W. 16th Ave., Vancouver 9, B. C., Canada

Medem, Jr., Ricardo — Pres., Sumasa; subdir., Ricardo Medem Y CIA, S. A.; attorney, Lanz Iberica, S. A. (Mail) 439 E St., Davis, Calif.

Oestmann, Walter G. — Vice-pres. and gen. mgr., Daco Inc., 149 S. River St., Aurora, Ill.

Owen, Herbert E. — Owner, Owen Implement Co. (Mail) 213 S. Fourth St., St. Joseph, Mo.

Palanivelu, P. — Agr. eng. supervisor, Soil Conservation Scheme, Coonoor, South India

Romen, Meir — Surveyor, Soil Conservation Service, Ministry of Agr., P.O.B. 3, Afula, Israel

Smith, Harry A. — Field engr., Calcium Chloride Institute. (Mail) 6117 Greenleaf Blvd., Racine, Wis.

Stallings, Jack H. — (With U. S. Air Force). (Mail) 1 Tyndall Circle, Waco, Texas

Taylor, Jr., William A. — Vice-president, Taylor Machine Works, Hy. 15 North, Louisville, Miss.

Turner, William K. — Graduate student, agr. eng. dept., University of North Carolina. (Mail) 2301 Lake Dr., Raleigh, N. C.

Whitley, John B. — R. 9, Box 237, Charlotte, N. C.

Willingham, Nelson H. — Power use engr., Consolidated Electric Co-op., R.R. 1, Mexico, Mo.

Winslow, John S. — Farm equip. product planning, International Harvester Co., 21st Floor, 180 N. Michigan Ave., Chicago, Ill.

Wright, Malcolm E. — Des. engr., Rockford Works, J. I. Case Co. (Mail) c/o D. S. Galbraith, 1 Melodia Court, New Orleans, La.

Zwiacher, Wayne E. — Proj. engr., Sunkist Growers, Inc. (Mail) 1517 W. Harvard Place, Ontario, Calif.

TRANSFER OF MEMBERSHIP

Armstrong, John S. — Gen. mgr., M/s Escorts Agents Ltd., Roshanara Rd., New Delhi, India (Associate Member to Member)

Blum, Jr., George B. — Asst. prof. agr. eng. dept., North Carolina State College, Raleigh, N. C. (Associate Member to Member)

Bowers, Wendell — Ext. spec., agr. eng. dept., University of Illinois, Urbana, Ill. (Associate Member to Member)

Bruwer, Jabez J. — Head, agr. eng. dept., Univ. of the Orange Free State. (Mail) Agr. Eng. Dept., Univ. of Pretoria, Pretoria, Union of South Africa (Associate Member to Member)

Clark, Charles E. — Proj. engr., Perfecting Service Co. (Mail) 5941 Wedgewood Dr., Charlotte 9, N. C. (Associate Member to Member)

Garner, Thomas H. — Instructor, North Carolina State College. (Mail) 5117 Melbourne Rd., Raleigh, N. C. (Associate Member to Member)

Greene, Ralph B. — In charge of agr. eng. res. shop, agr. eng. dept., North Carolina State College, Box 5514, State College Station, Raleigh, N. C. (Affiliate to Member)

Holmen, Harold — Asst. prof. of agr. eng., and asst. agr. engr., North Dakota Agr. College. (Mail) 38-18 Ave. N, Fargo, N.D. (Associate Member to Member)

Johnson, William H. — Res. instructor, North Carolina State College, Box 5906, Raleigh, N. C. (Associate Member to Member)

Jordan, Kenneth A. — Asst. prof., agr. eng. dept., North Carolina State College, Raleigh, N. C. (Associate Member to Member)

Preedy, Ernest L. — Assoc. engr., Boeing Aircraft Co. (Mail) 1613 144th St., S.E., Bellevue, Wash. (Affiliate to Associate Member)

Smith, Ralph E. — Asst. agr. engr., agr. eng. dept., Univ. of Georgia, Barrow Hall, Athens, Ga. (Associate Member to Member)

STUDENT MEMBER TRANSFERS

Adamson, Jerry F. — (Oklahoma State University) R.R. 2, Enid, Okla.

Davis, Bobby J. — (Oklahoma State University) 2028 Virginia, Chickasha, Okla.

Dester, Delbert D. — (Oklahoma State University) Deer Creek, Okla.

Dixon, Mack L. — (University of Kentucky) R.R. 1, Box 295, Ashland, Ky.

Edminston, Harlon R. — (Louisiana Polytechnic Institute) Box 418, Sterlington, La.

Hamilton, Harvey E. — (Oklahoma State University) Catesby, Okla.

Haynes, Gary D. — (University of Idaho) R.R. 2, Box 173, Pullman, Wash.

Hoskyn, John P. — (University of Arkansas) 730½ W. Maple, Fayetteville, Ark.

Hubbard, Larry L. — (Washington State University) 46-A N. Fairway, Pullman, Wash.

Krause, Dennis R. — (University of Nebraska) Adams, Nebr.

Krussel, James E. — (Washington State University) Box 357, Palouse, Wash.

Lindquist, Daniel A. — (University of Nebraska) SCS, USDA, Essex, Iowa

Mansperger, John H. — (Washington State University) R.R. 3, Ellensburg, Wash.

McCornack, John C. — (Oklahoma State University) Cloud Chief, Okla.

McElhannon, Ottis R. — (University of Arkansas) R.R. 2, Foreman, Ark.

Moore, Millard V., Jr. — (University of Kentucky) 3221 Blackburn Ave., Ashland, Ky.

Ondrusek, Robert — (Michigan State University) R.R. 6, St. Johns, Mich.

Pearce, Robert O. — (Washington State University) R.R. 1, Box 98, Granger, Wash.

Petermann, William G. — (Oklahoma State University) R.R. 2, Stillwater, Okla.

Pick, William A. — (University of Wisconsin) 419 N. Pinckney St., Madison, Wis.

Reddell, Donald L. — (Texas Technological College) High Plains Water Dist., 1628 15th St., Lubbock, Tex.

Reinhart, Charles L. — (University of Arkansas) R.R. 1, Box 165, Stuttgart, Ark.

Rice, Charles E. — (Oklahoma State University) 519 W. Miller, Stillwater, Okla.

Staab, Donald C. — (University of Wisconsin) 138 Roberta Ave., Waukesha, Wis.

Sutton, Ronald D. — (University of Richmond) R.R. 14, Box 440, Richmond, Va.

Thornton, Jim P. — (New Mexico State University) Box 538, Pyote, Tex.

Van Leuven, Don R. — (Washington State University) 301 Oak, Apt. D-2, Pullman, Wash.

Zoz, Frank M. — Agr. Eng. Department, University of Nebraska, Lincoln, Nebr.

PERSONNEL SERVICE BULLETIN

Note: In this bulletin the following listings current and previously reported are not repeated in detail. For further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this bulletin, request form for Personnel Service listing.

Positions Open (1959) — **November** — O-353-969, 360-970, 358-972. **December** — O-378-974, 384-975, 387-977, 370-980, 394-981, 404-982. (1960) — **January** — O-441-985, 452-986. **February** — O-4-601, 11-602, 35-605. **March** — O-55-606, 57-608, 66-609, 83-610, 21-611.

Positions Wanted (1959) — **November** — W-343-55, 363-57. **December** — W-390-59, 388-60. (1960) **January** — W-411-61, 426-62, 427-63, 433-64. **February** — W-3-1, 10-2, 15-3, 16-4, 17-5, 5-6, 33-8, 37-9, 30-10. **March** — W-46-11, 63-13, 62-14, 77-15, 69-16, 75-17, 73-18, 74-19, 76-20, 94-21.

NEW POSITIONS OPEN

Agricultural Engineer (Assistant), for research assignment with primary responsibility in area of mechanizing vegetable and field crop production, in a southern state agricultural experiment station. Age under 40. MS degree in agricultural engineering. Farm machinery research experience preferred. Able to work well with group of 30 agricultural scientists of various disciplines. Able to meet commercial growers in atmosphere of mutual confidence and understanding. Unusually interesting and promising opportunity for men with special interest in mechanization of vegetable and field crop production in a warm climate. Salary $6600-7400. O-105-612

Experimental Engineer in stress analysis. Must be a graduate with a BSAE or BSME degree. Must be familiar and have experience with application of stress coat, use of strain gages and use of different electronic equipment for measuring and recording and analysis of different phenomena. Work will include measurement and analysis of different phenomena related to machinery design for all types of agricultural machines and industrial equipment. Salary open. O-111-613

Agricultural Engineers (2) for research on cotton harvesting equipment, with federal agency. Location at a state agricultural experiment station. Age 25-40. PhD preferred. MSAE or equivalent required. Research experience in power and machinery. Usual personal qualifications for team research, plus ability and desire to work in this field. Excellent opportunity for advancement. Outstanding facilities for unhampered research achievement. Good schools, churches, community of about 6000. Good library facilities available at state university. GS-9 to 12 rating, depending on qualifications. O-114-614

Project Engineer for development of farm implements with growing company in upper Midwest. Age 23-40. BS or MS in agricultural or mechanical engineering. Experience in design of agricultural or other mechanical equipment, supervision of experimental construction, testing, and liaison during manufacture. Creative self starter, articulate, and able to work well with production, sales, management, and customer groups. Excellent opportunity with growing firm well established in farm equipment industry. Parallel salary administration program allows advancement in technical specialty or toward administration and management, according to preference. Salary $555-770 per month to start. O-115-615

Agricultural Engineer (Assistant professor in mechanized agriculture), for teaching and research in any phase of agricultural engineering at an eastern state university. MSAE required. PhD given special consideration. Some experience in field. Usual personal qualifications for college teaching and research. Good opportunity for advancement. Twelve months basis with one month vacation. State retirement system. Social Security program. Opening effective July 1. Salary open. O-95-616

Sales Development Engineer to work with dealers of leading manufacturer of pre-engineered steel buildings. Agricultural engineer with good farm background preferred. Age range 30-45. Several years good sales development background necessary in structures, farm equipment or related sales fields. Excellent opportunity for ambitious man with stable progressive company. Only top flight applicants will be considered. Salary open. O-126-617

NEW POSITIONS WANTED

Agricultural Engineer for design, development, research, extension or sales in rural electric, product processing, or soil and water field, with experiment station, federal agency, distributor or farming operation. Any location. Prefer South. Married. Age 23. No disability. BSAE, January 1960, Texas A. & M. College. Farm background. Four summers in construction work. Available on reasonable notice. Salary $300 per month. W-78-22

Agricultural Engineer for extension, teaching, research, or service in farm structures, rural electric, product processing or soil and water field, with public service, processor or distributor, preferably in South or Southeast. Married. Age 41. No disability. BSAE, 1950, Clemson College. Electrification advisor 3½ years. Selling irrigation equipment 1½ years. Research 4 years. Army enlisted service 3 years, World War II. Available on two weeks notice. Salary open. W-90-23.

Agricultural Engineer for design, development, or research in power and machinery with manufacturer in East or Midwest. Single. Age 29. No disability. BSAE, 1957, Technion, Israel Institute of Technology. Massey-Ferguson School of Farm Mechanization (England) 6 months. Special study at National Institute of Agricultural Engineering (England), 5 months. Design, development and testing of centrifugal water pumps for manufacturer 2 years. Research engineer on farm equipment 2½ years. Available now. Salary open. W-99-24

Agricultural Engineer for design, development, research, sales, or service in power and machinery with manufacturer, processor, or distributor in West or Midwest. Married. Age 34. No disability. BSA, major in agricultural engineering, 1959, Montana State College. Farm background. War service in Navy 2 years. Subsequent service in U.S. Air Force 16 months. Auto and truck mechanic 5½ years full time, plus 4 years part time while in college. Soil Conservation Service (GS-5) since graduation. Available on 2 weeks notice. Salary open. W-102-25

Agricultural Engineer for development or research in power and machinery with manufacturer in Southwest or Midwest. Married. Age 24. No disability. BS in agriculture, major in agricultural engineering, 1958, Texas A. & M. College. One summer farm work. Six summers with farm equipment dealer. Nine months enlisted service with Quartermaster Research and Engineering Field Evaluation Agency. Since December 1959, mechanical engineering assistant on developing and testing, Quartermaster Research and Engineering Command. Available November 1960. Salary open. W-96-26

Agricultural Engineer for sales, service, or management in soil and water field with public service or industry. Any location. Married. Age 42. No disability. BS in agriculture, 1940, University of Glasgow. Experience 20 years in farm, estate, and public lands management, including 4 years war service as Air Ministry Lands Officer. Available now. Salary $8000+. W-110-27

Agricultural Engineer for development, research, sales, service, or writing in farm structures or rural electric field with manufacturer, distributor, or consultant. Any location. Limited travel. Married. Age 28. No disability. BS in agriculture, 1955, Cornell University. Three summers farm work experience. Two summers in research on material handling, bulk cooling, and field sprayers. Agricultural engineering specialist, assistant county agent, one year. Farm service cadet and farm service representative electric utility, since 1956. Available on reasonable notice. Salary $7,500. W-127-28

Agricultural Engineer for design, development, research, or service in power and machinery, farm structures or rural electric field with industry or public service. Northern one-third of U.S. or Florida, Gulf Coast, or foreign. Married. Age 40. No disability. BS in agriculture, 1943, Cornell University. Dairy farm background, including 8 years operation. U.S. Army commissioned service, 3 years, including special training in motor vehicle maintenance. Assistant county agent. 5½ years. Available on 30 days notice. Salary $6,000+. W-12-29

Agricultural Engineer for design and development in power and machinery with industry or public service. Midwest or West. Married. Age 35. No significant disability. BSAE, 1952, Iowa State University. Design and development experience on rakes, mowers, balers, power chassis, tying mechanisms, and pneumatic separation, with established manufacturer. Available June 1. Salary $8,000. W-113-30

Agricultural Engineer for design, development or research in power and machinery with college. Any location. Prefer limited travel. Married. Age 22. No disability. BSAE expected June 1, West Virginia University. Farm background. Summer work experience, with power company, state road commission, farm, and university. Available June 20. Salary $4,500. W-117-31

PERSONNEL SERVICE BULLETIN

Agricultural Engineer for development or extension with experiment station, farming operation or trade association, anywhere in North or South America. Single. Age 22. No disability. BSAE, University of Arkansas. Farm background. Summer work experience in construction. Available now. Salary $400 per month. W-120-32

Agricultural College graduate for development work or writing in farm structures on soil and water field with federal agency or processor. Any location. BSA expected May 22, Southwestern Louisiana Institute. Farm background. U.S. Navy 5 years, with advancement from recruit to 2nd class petty officer, and experience including atomic defense study and wide range of carpenter work. Available now. Salary $400-425 per month. W-121-33

EVENTS CALENDAR

April 12-27 — *Milan Trade Fair,* Milan, Italy. Write to Edward K. Moss, 1025 Connecticut Ave., N.W., Washington 6, D.C., for details.

April 18-20 — *Seventh National Watershed Congress,* Washington, D.C. Write to The National Association of Soil Conservation Districts, Service Dept., League City, Texas, for further details.

April 19-21 — 15th *Annual Meeting* and *Lubrication Exhibit* of the *American Society of Lubrication Engineers,* Netherland Hilton Hotel, Cincinnati, Ohio. For further information address ASLE at 84 E. Randolph St., Chicago 1, Ill.

April 25-26 — 18th annual *Canadian Section Conference, The Society of the Plastics Industry, Inc.,* London Hotel, London, Ontario, Canada. For details contact SPI, 250 Park Ave., New York 17, N. Y.

April 25-29 — *American Welding Society's* 41st Annual Convention and Welding Exposition. Convention will be held in the Biltmore Hotel, and the Welding Exposition in the Great Western Exhibit Center, Los Angeles, Calif. For further details write Information Center, AWS, 33 W. 39th St., New York 18, N. Y.

May 3-5 — 15th *Purdue University Industrial Waste Conference,* Memorial Union Bldg., Purdue University, Lafayette, Ind. Additional information may be obtained by writing to: D. E. Bloodgood, professor of sanitary engineering, Purdue University, Lafayette, Ind.

May 10-12 — *Rural Electrification Conference,* Sheraton-Fontenelle Hotel, Omaha, Nebr. For details write to 1960 Rural Electrification Conference, P.O. Box 721, West Dodge Station, Omaha 31, Nebr.

May 11-12 — *National Institute of Agricultural Engineering, Open Days,* Wrest Park, Silsoe, Bedfordshire, England. Details may be obtained by writing to the above address.

May 18-19 — 3rd *Agricultural Meteorology Conference,* sponsored by the Kansas City Seminar of the American Meteorological Society, Kansas City, Mo. Additional information may be obtained by writing to AMS, 3 Joy St., Boston 8, Mass.

May 23-26 — *Design Engineering Show,* New York Coliseum, New York City. For information write to Clapp & Poliak, Inc., 341 Madison Ave., New York 17, New York

May 24 — *Farm Equipment Institute, Industry-Wide Spring Meeting,* Congress Hotel, Chicago, Ill. For further details write FEI, 608 S. Dearborn St., Chicago 5, Ill.

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(Continued from page 246)

Details for Annual Meeting Extension Exhibits

Now is the time for agricultural engineers in industry and public agency to prepare their exhibits for entry at the 53rd ASAE Annual Meeting, which is to be held at Ohio State University, June 12-16. The Committee on Extension is planning for an outstanding exhibit.

The exhibit classes include publications, demonstration models, movies, radio and television, slides and film strip and extension methods or recipes. Textbooks will be handled by the Education and Research Division. A certificate and blue ribbon will be awarded in all classes. Industry groups will not compete against the public agency groups and vice-versa.

A special letter and entry blanks have gone to ASAE members identified in the Society headquarters as engaged in extension work. Additional entry blanks are available from the Society and from members of the Extension Committee. Following is information on specific classes of exhibits.

Publications: Included in this entry will be bulletins and periodicals and these will be separated into industrial and public agency classes. Each ASAE member may enter one bulletin and/or one periodical. Write for an application blank to Donald W. Derber, agricultural extension section, U.S. Steel Corp., 2831-525 William Penn Pl., Pittsburgh 30, Pa.

Demonstration models are to "show developments having engineering implications relating to agriculture, the primary objective of which is the education of the viewer." Classes will be provided for public agency and industrial groups. Rules and regulations for entry of demonstration models may be obtained from William E. Gill, extension farm machinery specialist, Ohio State University, Columbus 10, Ohio.

Movie awards will be made in two classes, those prepared by industrial or commercial organizations, and those developed by colleges, universities and other public agency groups. Any group or any individual who has developed a movie during the past year is eligible to enter competition for this blue ribbon by writing Donald L. Maxwell, Portland Cement Association, 33 W. Grand Ave., Chicago 10, Ill.

Radio and TV Exhibits: Any charts, photographs, slides and other specimen used in the preparation of television and radio materials that might make interesting exhibits for ASAE can be entered by writing for an application form from Donald Brown, extension agricultural engineer, Michigan State University, East Lansing.

Slides and Film Strips are some of the most effective teaching aids in extension programs. A set of slides or film strips showing agricultural engineering developments or how to teach some phase of agricultural engineering may be submitted. There are two classes, one for industrial and commercial groups and one for the public agency group. For applications on slides and film strips write to R. O. Gilden, extension agricultural engineer, Federal Extension Service, USDA, Washington 25, D. C.

Extension Methods and Recipes: This phase of the exhibits gives the extension agricultural engineer an opportunity to swap ideas on how best to carry out certain jobs connected with his work. Write Leo T. Wendling, extension agricultural engineer, Umberger Hall, Kansas State University, Manhattan, for an application.

Closing dates for entries in all classes will be about June 1.

Materials Handling Theme for FEI Spring Meeting

The Farm Equipment Institute Production and Marketing Department has chosen "Revolution in Materials Handling on the Farm" as its theme for its Industry-Wide Spring Meeting, to be held on May 24 at the Congress Hotel, Chicago, Ill. Meeting Chairman Arnold Skromme, chief product engineer, John Deere Spreader Works, points out that the theme will be explored from the manufacturers' point of view with special emphasis on planning, evaluation, manufacturing, and merchandising.

LeGrande Kelly, production and marketing department chairman, will call the meeting to order, followed by H. E. Pinches, who will give the opening remarks. The topics to be covered on the program are: Buildings (including silos and self-feeders), by R. L. Crom, general manager, Butler Manufacturing Co.; bulk materials handling machines, by A. A. Kole, vice-president and general manager, Farmhand Co.; silage and barn-manure equipment by Vincent Rohlf, president, Badger Northland, Inc.; feed processing equipment, by D. R. Dahnert, Waterman Electric Co.; milking equipment, by M. W. Herrmann, vice-president, Perfection Manufacturing Corp.; water systems, by G. A. Patterson, market research director, Sta-Rite Products, Inc.; a panel discussion; marketing, by George Serferovich, editor, *Implement and Tractor Magazine;* and the state of the industry panel discussion.

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Whether you're a corn farmer or a grain man, you'll thrill to the command of Oliver's new self-propelled combine. You have the power and threshing ability to pick and shell 1960's over-100-bushel yields—even when the foliage is extra heavy. In grass seeds, soybeans and all small grains, you'll enjoy the capacity to wade right through.

Here is a *new combine with proven ability*—holder of high acclaim in hundreds of locations, from 1959's drought-stricken prairie crops to the 115-bushel oats of northeastern Ohio and the over-100-bushel corn crops in Illinois.

It's the combine for medium-size farms with a wide variety of crops. Best of all, its price tag is far smaller than its workability and its savings. You get 11% more power than the average of all comparable models, the biggest separating area of its class, your choice of two headers—including Oliver's field-proven 2-row corn head. Here you get "live" snapping rolls, three gathering chains per row, and all the crop-saving features of Oliver's famous corn pickers.

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The official ASAE Membership Certificate, available to ASAE members only, measures 10¾ by 14 inches. It is engraved on heavy parchment paper and is suitable for framing. The member's name, grade of membership, and month and year of admission to the Society are engrossed by hand. The certificate is signed by the President and Secretary and bears the official (gold) seal of the Society. The price of the certificate, including engrossing, is $3.00. Order direct from

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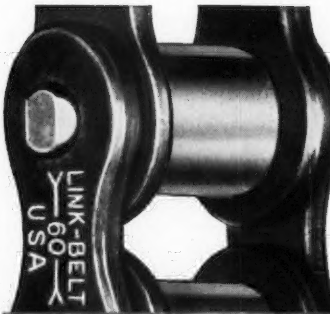

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